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Regional drainage basin morphometry

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REGIONAL DRAINAGE BASIN MORPHOMETRY.

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REGIONAL DRAINAGE BASIN MORPHOMETRY

by

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PREFACE

This study started originally with the rather vague idea of relating morphometric parameters to something other than themselves. The lack of success of local studies in attaining this goal led me to consider a regional study. The justification of such a departure from the current tendency of working in more and more restricted areas was that the heterogeneity of nature - random movements - may mask any trends that might exist, whereas a regional study might recognize a trend. Implicit to the foregoing argument is the premise that a recognizable trend probably will account for only a small portion of the total observable variability.

As the study progressed my inability to recognize the implications of several morphometric studies led to a search for hidden assumptions in these studios; this search was to a large degree futile. A growing awareness that morphometric studies are such a radical departure from traditional studies in geomorphology that there was no broad general framework within which to work led to consideration of the philosophical basis of quantitative studies.

I would like to express my deepest gratitude to Professors Richard L. Handy, David V. Huntsberger, Keith M. Hussey, Howard P. Johnson, John Lemish and to wife, Lolisa, all of whom kindly read this manuscript and contributed valuable criticisms and suggestions. The Computation Center of Iowa State University's Statistical Laboratory provided liberal computer services.

GLOSSARY OF NEW AND MODIFIED TERMS

Adventitious streams are those streams below the junction of two order-forming streams that intersect the higher order stream segment.

An element (of a landform), i.e. the nose, sideslope, hollow (Hack and Goodlett, 1960) is a uniform, geomorphic entity which represents the elemental geomorphic system.

A form (of a landscape) is made up of one or more elements.

A form field is an aggregation of similar forms which develop relatively close to each other, such as a drumlin field.

A formal race is an aggregation of adjacent, similar forms.

A landscape is an aggregation of dissimilar forms.

INTRODUCTION

The philosophical basis of any quantitative study should provide a framework within which advances in knowledge and understanding can be made and hidden assumptions searched out. That is, philosophy is concerned with generalities, whereas science is concerned with specifics, and the specifics of nature should fit meaningfully into the generalities. There appears to be a tendency in geomorphology to ignore the philosophical questions and to accept the measurements of morphometric parameters as an objective of study, whether or not they have any significance in the real world. In theory these studies are an investigation of the measured, geometrical properties of landscape, whereas in practice these studies represent a program of carrying out certain operations of measurements and deriving relationships from the results.

The idea of an investigation of the geometrical properties of the landscape furnished the imagination with a model, and the experimenter with a guide to types of measurements that might be carried out. If this idea is abandoned, many of the present results cannot stand on their own, that is, the results are descriptions, not explanations; furthermore the morphometric data and the derived empirical relationships do not all agree with each other. Until the results can stand on their own the geologist will be closely restricted by the idea; thereafter he can devise a model based on the results rather than the idea. In other words, until the data can stand on their own the philosophy associated with morphometric studies will be strongly rational, and, thereafter, it will be strongly empirical.

The objective of an initial formulation of the problem should be an attempt to remove the conflict in the data rationally rather than by the collection of more data. A search for a solution may begin with what has been proved or with what is believed. Since this problem is, in part, a challenge of the collected data, then the latter approach will be used.

In either a rational or an empirical study, models are an aid to investigation and have significance only when the conceptual models do, in fact, agree in some way with the real world. This agreement suggests that there must be criteria by which to evaluate the degree of agreement. First, a model of some process is often said to be validated when it can be used in prediction with a large degree of success; time usually plays a prominent role in these models and rate of change refers to some change with respect to time. Similarly it is possible to conceive of a model in which space plays a prominent role.

Second, when dealing with prehistory, it is desirable initially to organize the data into easily remembered categories. Later, these data may be combined in such a way so as to aid in the search for other data. In either case these organizations of the data are classifications and as such are models. The former model is a descriptive classification and is said to be validated when the data fit easily into the categories. The latter model is a genetic classification and is said to be validated when its prediction value is high. Classification schemes may be grouped in several classes ranging from purely descriptive to purely genetic classifications. Some of these models may be more fruitful in terms of generating ideas than other models which may have a higher degree of validity.

Another type of validating criteria is the principle of verifiability which states that the meaning of a proposition is the method of its verification; in other words, to say that one understands, or knows the meaning of, any given proposition, is to say that one knows how to verify it. This principle cannot be applied too rigidly or many of the principles, laws, and models that have been developed would fall.

The study of concepts involves (1) an examination of the mutual relationships between the concepts and the statements made about them; and (2) an investigation of how the concepts are related to the real world. Even before the search begins two disturbing side effects must be recognized. First, the wills of men are often stronger than their intellects. Second, men are a product of their environment and training, and as such, may not be free to deliberate. The presuppositions, whether made consciously or unconsciously, tend to be dictated by the environment rather than by the individual.

The geologist's environment, training, and wanderings over the surface of the earth lead him to a space-time concept derived from a consideration of the geometry of the forms in his study area and of their spatial distribution. His concept of time is derived from, among other things, the conviction that strata are laid down in a certain temporal sequence. These concepts of space and of time may then be integrated into a coherent concept of space-time by constructing a moving picture of form-development in time; this consideration of motion is called kinematic analysis. Consideration of the forces and factors responsible for the motion is the basis for a full dynamic analysis.

In the study of the geometry of landforms it is extremely difficult to develop a concept of time because the geometry yields no evidence of what has happened in the past. The geometry of a landscape, considered alone, does not tell us anything about the relative age of the individual forms that comprise that landscape; in other words it is difficult to equate a purely spatial change to a purely temporal change. It is just as difficult to visualize a spatial change as separate and distinct from a temporal change.

If spatial and temporal concepts are compared and contrasted, the differences between them are not great, except for the impression that time seems to pass. The concept of occupying a place applies equally well to space or time or both space and time. The notion of an interval likewise applies equally well to space or time or both space and time. The concept of an interval leads to consideration of parts of the interval and this leads to a similar conclusion. The concept of an object has both kinds of length and of parts and must also involve space and time. If the landscape is defined as a system contained within more or less well defined boundaries, it also must involve space and time.

The distinction between space and time is often made on the basis that no object can occupy two places at the same time; whereas it can occupy the same place at two different times. "Place" is defined as the volume occupied by the object in space-time. There are several ways that an object can occupy the same place at two different times. The landscape might remain at one location through some interval of time. It might have moved through space only to return to its original location through uplift and rejuvenation. If a landscape occupies the same place at two different times, we may assume that it has existed throughout the entire time interval; otherwise it may not be the same object that is being considered. It is a different temporal part of the landscape which occupies the same place at two different times.

Similarly, the landscape may occupy two places at one time if it occupies the entire space interval; for example, a pencil occupies two places at once, if the places referred to are those of its opposite ends. In this case it is a different spatial part of the landscape which occupies two different places at the same time. These arguments imply that the object that has moved through space or through time is the same object over the interval under consideration. This requirement necessitates an exact description of the object, in this case the landscape.

When one considers different temporal parts of an object, it is mandatory to know that that object not only existed but also was connected through the entire time interval; otherwise one would not know whether he was dealing with the same object or merely a similar object. In geology it is supposed that most landscapes change in appearance through time. It is not inconceivable to the followers of Davis that a similar landscape may occupy the same place at two different times as a result of rejuvenation, even though developmental changes have occurred during the temporal interval. Are these two similar landscapes the same landscape? It is also conceivable that two similar landscapes exist in two places at the same time. Are these two similar landscapes the same? The fact that the landscape exists through the interval does not help because existence is not an attribute; therefore existence cannot be a defining property of anything. It would be arbitrary to state that in one case they were the same landscape, and in the other case they were not the same landscapes, because the two situations are analogous. It is necessary to have an additional criterion, besides existence, to determine if two similarly described landscapes are the same or similar, namely, continuity through the interval.

Since geologists are concerned with temporal and spatial passage in relation to objects, they must relate the elements of their description of objects to such passage. It is quite easy for man to visualize his passing into, through, and out of existence and to visualize his growing older while he exists. It is also easy for him to impose these impressions on nature. It is much more difficult for him to construct an analogous argument for spatial passage in regards to himself, i.e. walking over the landscape takes time; likewise, it is difficult for him to impose such an impression on nature, even though he might recognize both temporal and spatial passage. It would thus appear that for man, as regards to himself, that temporal passage has significance, but spatial passage does not. Spatial passage probably presupposes temporal passage for most men, as would any kind of change. Temporal passage may or may not be accompanied by changes in appearance as a result of becoming older. If the assumption is made that all objects will change in time provided the interval is long enough, it implies that the parameters chosen to characterize the change may or may not be insensitive to change over the interval that they are applied. The assumption itself presumes that a time framework exists in which simultaneous measurements can be made. The degree of simultaneity required for a given study increases as the sensitivity of the chosen parameters increases. Moreover it has not yet been determined which morphometric parameters are most sensitive at which map scales, or even if the same parameter at different scales is sensitive to the same phenomena.

To summarize space-time: (1) A concept of space is derived from the geometry of objects. The concept of an object implies that it endures through space and time. For two objects to be the same they must be connected through the interval. For two objects to be similar means that they were not connected through the interval. For objects to be the same or similar implies that their exact descriptions be the same. Description must include some reference to time as well as space if objects are to be resolved into the same or similar objects. (2) The fact that most men in general look upon time as a series of events, and stratigraphers, in particular, look upon time as series of strata and lacunas, it is easy to see why time is considered a one-dimensional series. The stratigrapher working with strata has several ways to relate his object of study to time. A geomorphologist, however, more often than not has no coordinate system to which to refer objects in time. A time framework for events that occur in space whether or not they are separated by some distance is absolutely senseless if something about the simultaneity of events cannot be stated. Nevertheless such a time framework might serve as a classification, in spite of the fact that it is senseless, until it is modified and/or replaced by a better model. Thus the use of "space-time". The idea of passage or flow of time is essential to the concept of time, thus to deny the sequence would be to deny that time is real.

A controversy exists between the proponents of the geographic cycle and of dynamic equilibrium. Aside from the fact that the major protagonists may have been misread, the major point of the controversy in its extreme form is whether or not landforms are time-dependent or time- independent, in the sense that landforms are or are not accompanied by changes in appearance with the passage of time. The concept of time-dependent landforms is based on the assumption that landforms pass into, through, and out of existence, and these landforms grow older while they exist.[1] A statistical analysis of a sufficiently large, random sample of time-dependent landforms should yield the correct proportion of landforms in all stages of development that any given landform spends in successive stages. Such a statistical analysis is based on the additional assumption that landforms come into existence at some constant rate.

The concept of time-independent landforms, in its extreme form, is based on the assumption that landforms come into existence but do not change with the passage of time. Any changes in form that occur, in response to changes in the environment, occur for practical purposes instantaneously. In other words progressive changes do not occur in the landforms, even though the changes that do occur are predictable in the sense that a given landscape will exist in a given environment.

THE STUDY AREA

General Statement about Kansas

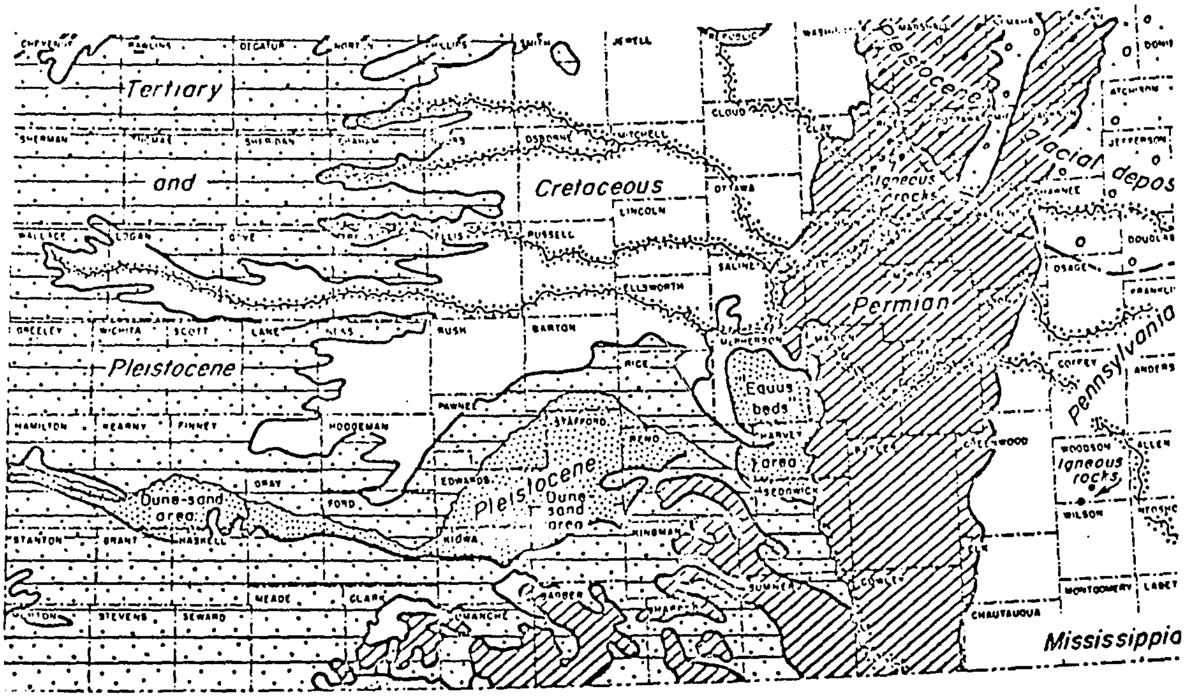
The topography of Kansas does not possess strong relief; nonetheless several contrasting topographic regions can be recognized, each of which possesses characteristic internal features that approximately coincide with the geologic and climatic regions of the state. There is an east to west change in elevation (700'-1000'); precipitation (40"-15"); geologic age of exposed pre-Pleistocene strata (Pennsylvanian-Pliocene); and topographic regions. Only that portion of Kansas contained in a part of the Smoky Hill River valley is considered in this report.

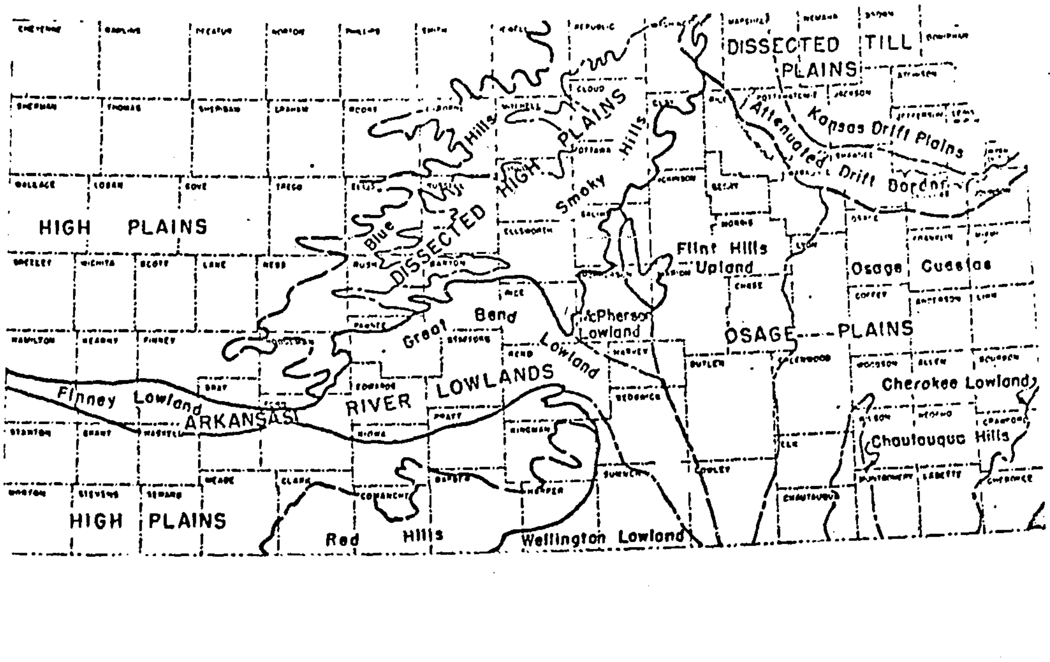
General Statement about the Smoky Hill River Valley

The Smoky Hill River rises in eastern Colorado and flows east to its junction with the Republican River, near Junction City, Kansas, to form the Kansas River. That portion of the Smoky Hill River drainage basin west of its junction with the Saline River, at Salina, Kansas, is the area from which the morphometric data used in this report were collected.

West of Ellis and Rush Counties, Kansas, the lesser tributaries of the Smoky Hill River rise in the Cenozoic formations, whereas the larger tributaries and the main stream itself have cut through the Cenozoic strata to the Cretaceous strata (Figure 1). The main part of the Smoky Hill River flows on Cretaceous rocks continuously from the western part of the state to Salina, Kansas; from there it flows on Permian rocks throughout the remainder of its course.

Figure 1., The upper map is a generalized geologic map of Kansas; The lower map is a physiographic map of Kansas (Schoewe, 1949)


Tertiary
and
Cretaceous
Pleistocene
Pleistocene
glacial depos
Igneous rocks
Permian
Pennsylvania
Equus beds area
Dune-sand area
Pleistocene
Dune sand area
Igneous rocks
Mississippia


DISSECTED TILL PLAINS
Kansas Drift Plains
Attenuated Drift Border
HIGH PLAINS
Blue Hills
DISSECTED HIGH PLAINS
Smoky Hills
Flint Hills Upland
Osage Cuestas
Great Bend Lowland
McPherson Lowland
OSAGE PLAINS
Cherokee Lowland
Finney Lowland
ARKANSAS RIVER LOWLANDS
Chautauqua Hills
HIGH PLAINS
Red Hills
Wellington Lowland

The series of geologic strata through which the Smoky Hill River has cut its channel results in a variable discharge. Haworth (1897, p. 261) states that where a stream rises in the Tertiary strata and has cut its channel approximately to the Cretaceous strata, it is supplied with enough ground water to maintain perennial flow. Farther to the east, where the channel has been cut well into the Cretaceous strata, there is only intermittent flow. East of Russell County the Smoky Hill River cuts into the Dakota Sandstone and again is a perennial stream.

The Smoky Hill River valley floor in Grove, Trego, and Ellis counties is from 300 to 400 feet below the bordering uplands. The tributaries have also cut deep valleys two to four miles back from the main stream. The rocks through which the channel is cut in these three countries are the Niobrara chalk beds. The relatively uniform lithology of these beds results in the development of a rugged landscape, quite different in appearance from that in areas underlain by varied lithology. Farther west where the main part of the bluffs is composed of Tertiary materials, the landscape is less rugged.

The floodplain of the Smoky Hill River is seldom more than a mile in width west of Ellsworth, Kansas, east of which it gradually becomes wider. The floodplain deposits are rarely over 20 feet thick.

The Smoky Hill River flows through two geomorphic sections of the Great Plains physiographic province: the High Plains and the Dissected High Plains sections (Figure 1).

High Plains

Approximately one-third of the Smoky Hill River Valley lies within the High Plains, which are bounded on the east by the prominent scarp of the Fort Hays Limestone (Niobrara Formation, Cretaceous) for 150 miles northeast from Finney County (Fry and Leonard, 1952, p. 202).

The broad interfluves in the High Plains are monotonously regular with a regional eastward slope of about 10 feet per mile. Much of this surface is underlain by late Pleistocene loess and locally by eolian sand resting on earlier Pleistocene deposits or the Ogallala (Pliocene) Formation. Much of the High Plains upland surface is not drained by integrated surface channels. Local drainage systems develop which are not integrated with any through flowing stream.

The Smoky Hill River heads in the plains area of east-central Colorado and occupies a valley 15-45 miles wide cut in Cretaceous bedrock in the High Plains section. The valley is characterized by a series of sweeping flanking pediments thinly veneered with colluvium and loess (Fry and Leonard, 1952, p. 203). The intersection of this valley and the upland surface is marked by an abrupt change of slope.

The upland surface is characterized by many thousands of various sized depressions. They range from one foot deep and 10 feet in diameter to several tens of feet deep and several miles across. Several geologists have speculated on their origin (Haworth, 1897; Johnson, 1901; Darton, 1905; Smith, 1940; Fry and Schoff, 1942; Evans and Meade, 1945; Fry, 1950; Judson, 1950). The depressions have been variously attributed to wallowing of buffalo, solution-subsidence, wind scour, differential eolian deposition, differential compaction, and silt infiltration. Probably most if not all these processes have had a share in the development of High Plains depressions, but the most important factor permitting the widespread development and preservation of surface depressions is the general absence in this region of processes that tend to inhibit development or promote destruction of such features (Fry and Leonard, 1952, p. 203).

Pedimentation has been important in shaping the major valleys and only solution-subsidence depressions have been observed on the flanking pediment surfaces (Fry and Leonard, 1952, p. 203). The flanking pediments of relatively low relief of the Great Plains region differ from mountain pediments in their magnitude and their consistent control by the position of through-flowing streams (Fry and Leonard, 1952, p. 27). Flanking pediments are broad, slightly concave upward, smooth surfaces which meet the steep valley-side wall with a more or less distinct curve. Bryan (1940, p. 261) recognized that the transition from pediment to valley slope should become more gentle as one proceeds from arid to humid regions. Flanking pediments, in the study area, are developed on Permian, Cretaceous, Pliocene, and Pleistocene strata; however they have their most ideal expression in the thick relatively homogeneous and massive Smoky Hills Chalk (Fry and Leonard, 1952, p. 27). Flanking-pediment veneers range in thickness from a trace to more than 20 feet and in texture from well to very poorly sorted, but their lithology in all cases reflects the upslope source.

Dissected High Plains

The Smoky Hills physiographic section (Fry and Leonard, 1952, p. 205) is equivalent to the Dissected High Plains section (Schoewe, 1949, p. 276).

Schoewe subdivides this section into a western part, Blue Hills, and an eastern part, Smoky Hills. These subsections coincide closely with changes in bedrock. The Blue Hills subsection is bounded on the west by an escarpment capped by the Fort Hays limestone. The Smoky Hills subsection is dominated by hills composed of discontinuous lenticular sandstone bodies in the Cretaceous Dakota Formation. The entire section is featured by a well-drained, moderate to coarse-textured topography.

RELIEF AND HYPSOMETRY

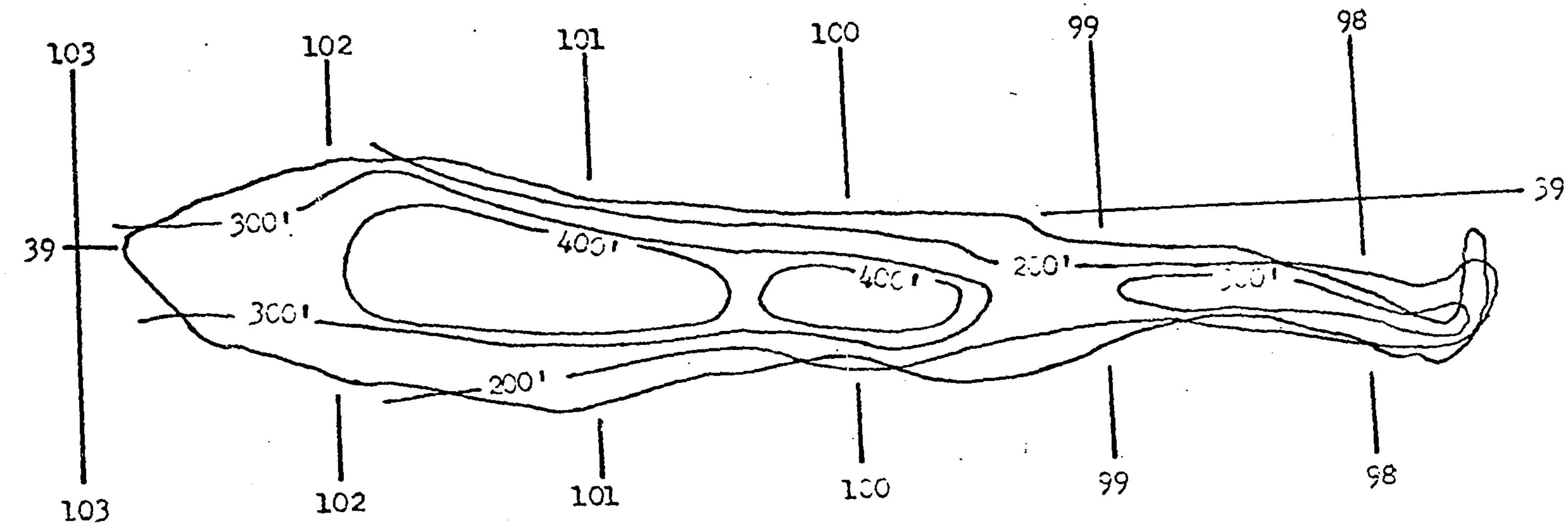
General Statement

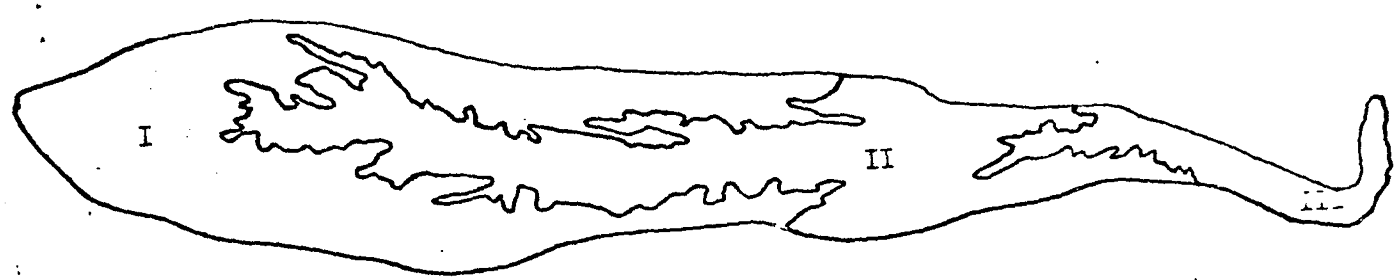
Hack (1965, p. 24) has stated that the local relief in a region of homogeneous rocks should be approximately uniform and that the local relief in areas of different rock types will be quite variable because drainage densities, stream profiles, and shape of the interfluves may all differ. He defined the local relief as the vertical distance from a hilltop to a valley or stream adjacent to it, yet he measured it as the maximum relief of a square mile area. This value was plotted and the resulting values contoured.

The local relief of the Smoky Hill River valley was measured as the maximum relief of a six-mile square area. The greatest amount of local relief occurs in Grove, Trego, and Ellis counties where the tributaries have cut valleys with a local relief of about 400 feet, two to four miles back from the main stream (Figure 2). The rocks through which the channel is cut in these three counties are the Niobrara chalk beds. Farther west where the main part of the bluffs is composed of Tertiary materials, and farther east where the main part of the bluffs is composed of Dakota Sandstone, the local relief decreases.

The distribution of relief in different drainage basins is thought to be comparable through hypsometric curves. Such curves can be constructed in two ways: (1) determine, with a planimeter, the area of all the terrain above successively lower contour lines within a drainage basin (Strahler, 1952); (2) by counting the number of random points above successively lower contour lines within a drainage basin (Thomas Hahn, Department of Agricultural Engineering, Iowa State University, Ames, Iowa,

Figure 2. Local relief (upper map) and generalized geologic map (lower map) of the Smoky Hill River Basin. Unit I includes the Ogallala and Arikaree Formations. Unit II includes the Montana Group, Niobrara Formation, and Benton Shale. Unit III is the Dakota Sandstone. The contour interval of the local relief is 100 feet.


103
102
101
100
99
98
39
300'
400'
400'
200'
300'
200'
39
103
102
101
100
99
98


I
II
III

personal communication). The median elevation of a drainage basin is the elevation which splits the basin area such that half of the basin area is lower and half higher than the median elevation. The median relief is the difference between the median elevation and the elevation of the lowest point in the basin. The median elevation may be read directly from area-elevation curves and can be compared directly with percentage hypsometric curves of different basins.

The median elevation of the Smoky Hill River is about 2750 feet and its median relief is about 1585 feet. A percentage hypsometric curve for the entire fifth order Smoky Hill River basin is shown in Figure 11. Hypsometric curves were then constructed for all fourth order basins within the fifth order basin in the hope of recognizing some consistent change in their shape, especially with regard to the interfluves. No progressive change was readily apparent. This dilemma led to further consideration of the factors which can affect the shape of this curve and also the hypsometric integral, which is the ratio of the area below the constructed curve to the total area.

Factors Affecting the Hypsometric Integral

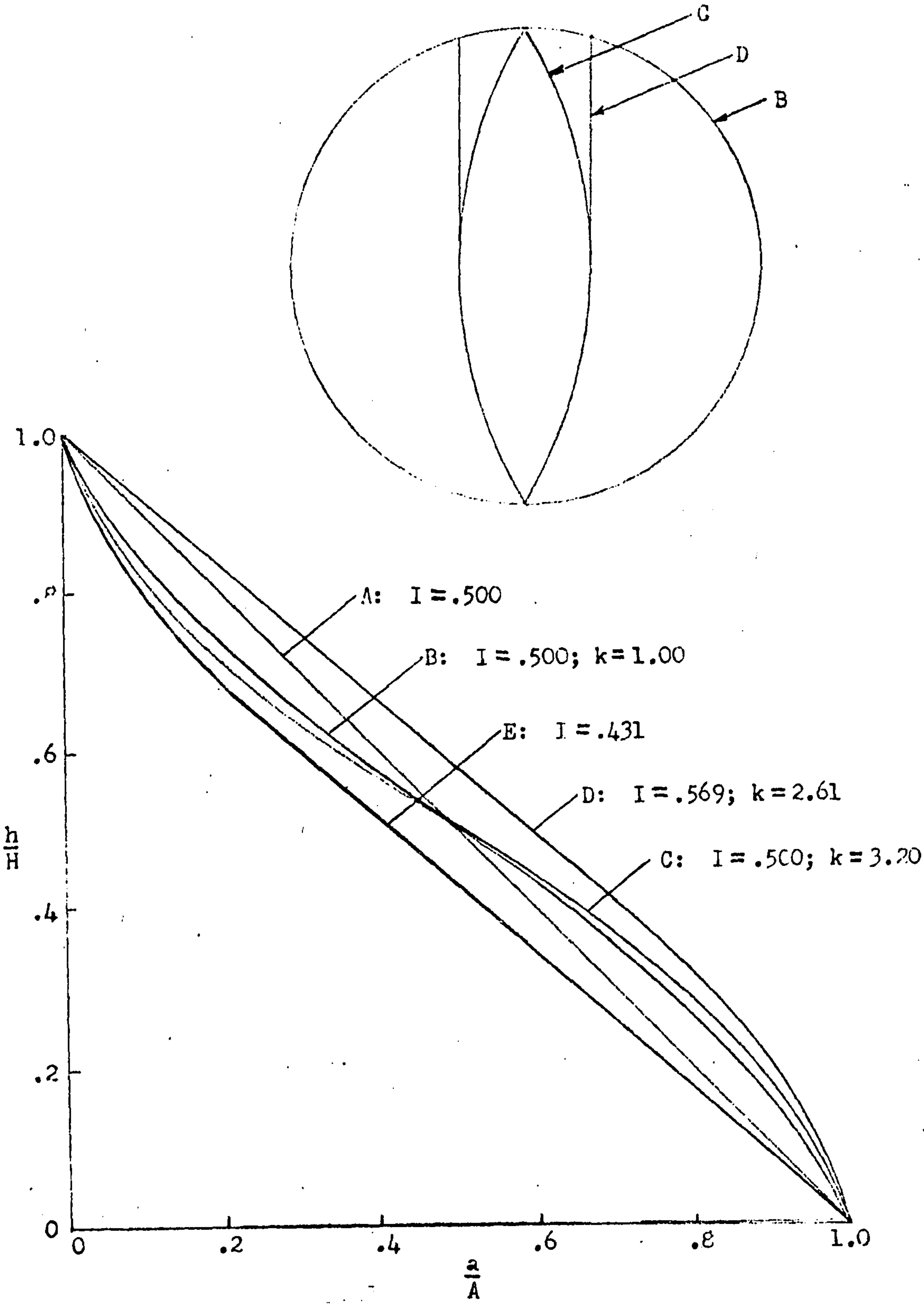
The hypsometric integral, I, depends to varying degrees (1) on the planar shape, k, of the basin, (2) on the distribution of relief in the basin, (3) on the amount and distribution of areas of noses, side slopes, and hollows of the basin, (4) on the orientation of the contour lines in the basin, and (5) on the degree of asymmetry of the basin. In the following discussion, idealized geometric forms are used to evaluate these various factors.

Shape factor

The effect of basin shape, k, on I may be illustrated by dividing the stream in the idealized basins of various shapes (Figure 3) into 10 equal segments and drawing lines perpendicular to the stream at these points. These strips of area may be considered either as strips of area of equal width, or as contour lines representing a surface of constant slope. By planimetering the area in the former case a measure of centroid of the area is obtained, whereas in the latter case the hypsometric integral, I, is obtained. In either case the results are the same and the method of obtaining the results is the same. In the discussion that follows the letter I is used to indicate the results for either case, and the lines perpendicular to the stream will be referred to as "contour lines" for either case. The hypsometric curve A (Figure 3) is the curve for any rectangular shaped basin provided the stream is parallel to one side; it is a straight line for which I = 0.5 regardless of the value of k. The hypsometric curve B is for a circular basin, k = 1; it is S-shaped, and I again equals 0.5. For $k > 1$ the S-shape of the hypsometric curve, C, becomes more pronounced, and I remains equal to 0.5. If the upper reach of basin C is made rectangular (curve D), k decreases, and I increases; if the lower reach of basin C had been made rectangular (curve E), k decreases as before, but I also decreases.

The tendency outlined in the proceeding paragraph may be generalized: first, if tangents are constructed at the same relative points on both sides of basin C at a progressively increasing distance from the head of the basin to give a trapezoidal headwater area, the total area, A, will

Figure 3. Idealized Basins of various shapes and their hypsometric curves for equally spaced contour lines.


C
D
B
1.0
.6
.4
.2
0
h/H
A: I = .500
B: I = .500; k = 1.00
E: I = .431
D: I = .569; k = 2.61
C: I = .500; k = 3.20
0
.2
.4
.6
.8
1.0
a/A

increase, k will decrease, and I will increase to a maximum then decrease to 0.5; second, if tangents are constructed as before except in the opposite direction to give a trapezoidal shape to the lower reaches of the basin, the area, A, and the shape, k, will increase and decrease, respectively as before, but I will decrease to a minimum then increase to 0.5. It is interesting to note what happens to the centroid: in the first case the centroid will initially migrate upstream before returning to its original position; in the second case just the opposite occurs.

It can be concluded (1) that a change in k will not result in a change in I if all other factors remain constant even though the shape of the hypsometric curve may change, (2) that a change in k will result in a change in I if the centroid of the planar area changes with all other factors remaining constant.

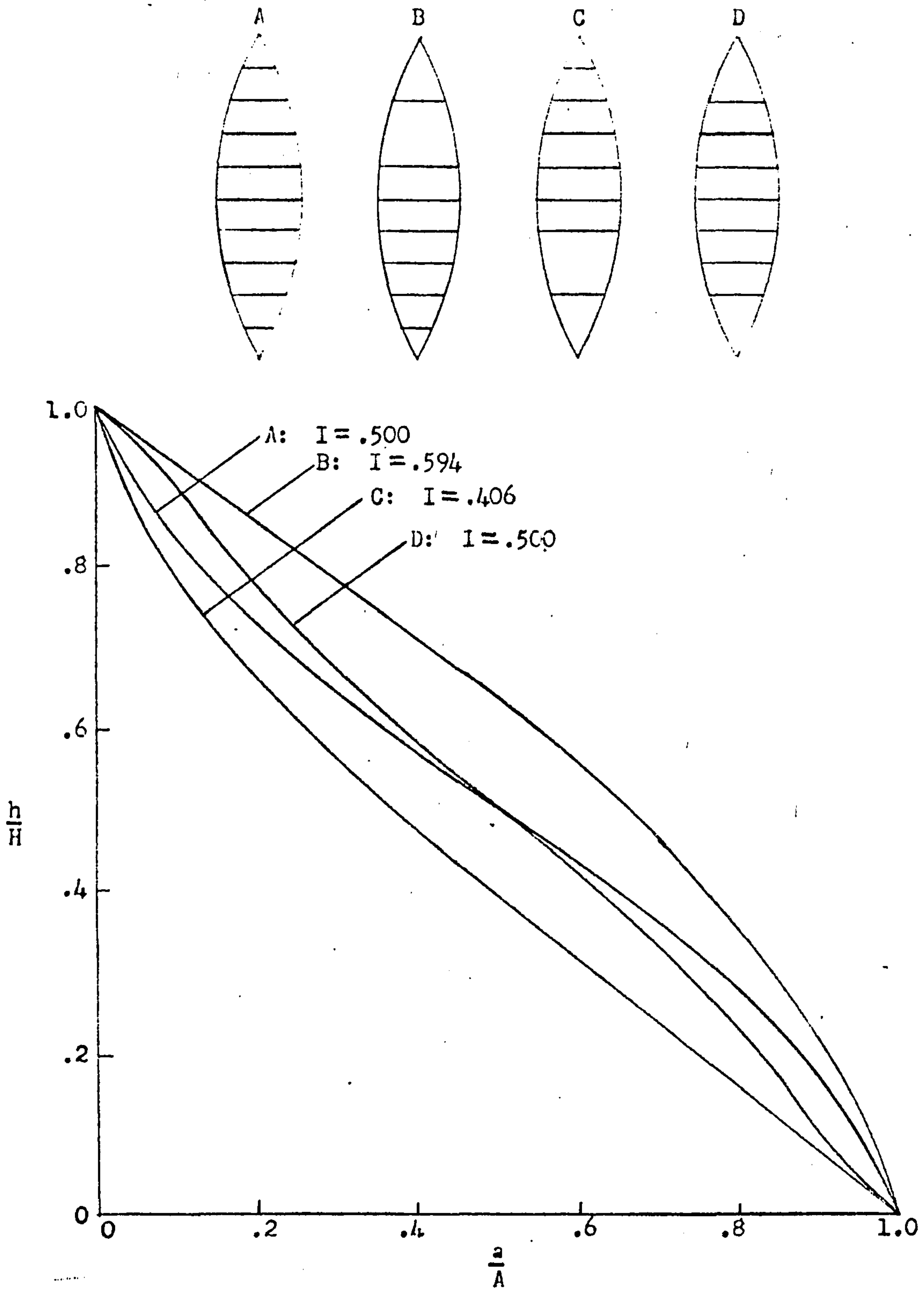
Centroid of the volume

A similar set of conclusions can be made if the centroid of the volume is considered for a constant k: (1) if the centroid of the volume does not change, I will not change even though the shape of the hypsometric curve may change; (2) if the centroid of the volume changes, I will also change, and the change will be in the same direction as the change in the centroid (Figure 4). The spacing of the contour lines in all the following hypothetical basins resulting in hypsometric curves labeled A, B, C, and D will be the same as in Figure 4, even though only the spacing for curve A will be shown.

Amount and distribution of areas of noses, side slopes, and hollows

The effect of the amount and distribution of the area of the nose,

Figure 4. The hypsometric curves for a basin with the idealized shape shown for different arrangement of the contour lines.


A
B
C
D
A: I = .500
B: I = .594
C: I = .406
D: I = .500
1.0
.8
.6
.4
.2
0
h/H
0
.2
.4
.6
.8
1.0
a/A

side slope, and hollow of a basin is illustrated for a basin in which k and the centroid of the planar shape are constant, but the centroid of the volume varies (Figures 5-8). The value of I decreases for any given distribution of relief for a basin composed of all side slopes, to one composed of nose and side slopes, to one composed of side slopes and hollow, to one composed of nose, side slopes, and hollows. It may be concluded that as the contour lines become more crenulated, I should increase.

Orientation of contour lines

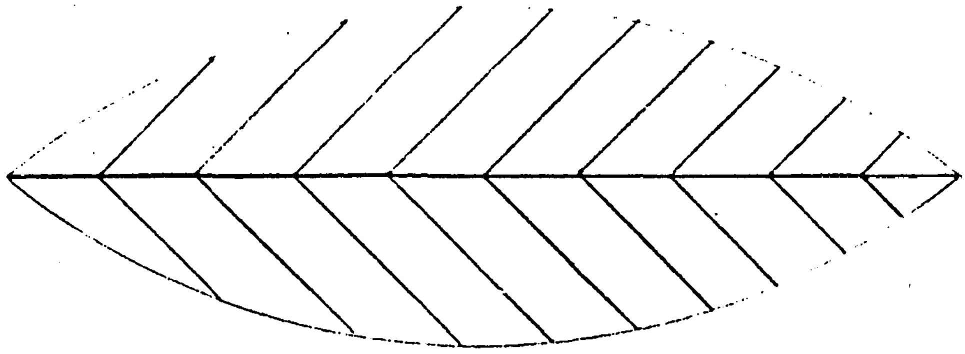
A comparison of Figures 4, 5, and 9, in that order, illustrate the effect of progressively decreasing the angle formed by a single contour line as it crosses a basin entirely in side slopes with all other factors constant. As the angle decreases, I increases.

Asymmetry

An increase in the amount of asymmetry will also cause I to increase (Figures 5 and 10).

The hypsometric integral, I, is a function of, at least, the five factors discussed above, and these factors are interdependent. It would be desirable to isolate the contributions of each of these effects to the hypsometric curve. The relationship of the planar shape to I is not too clear. From the above considerations one would be tempted to say that the major contribution to the hypsometric curve would be the distribution of relief; however, for the examples used in this paper one might be inclined to attribute the major contribution to the planar shape.

Figure 5. The hypsometric curves for an idealized basin composed entirely of side slopes for the four arrangements of the contour lines shown in Figure 4.



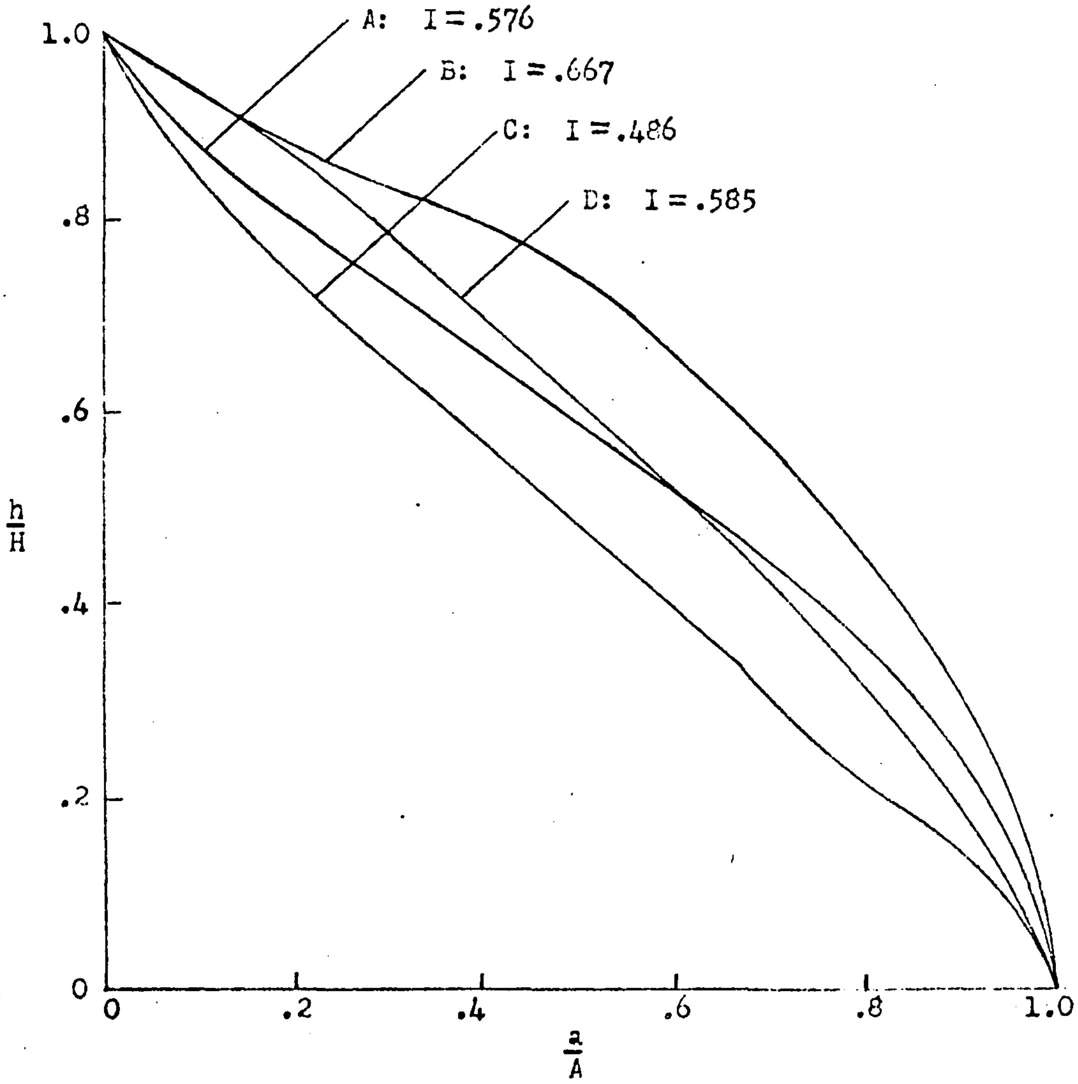
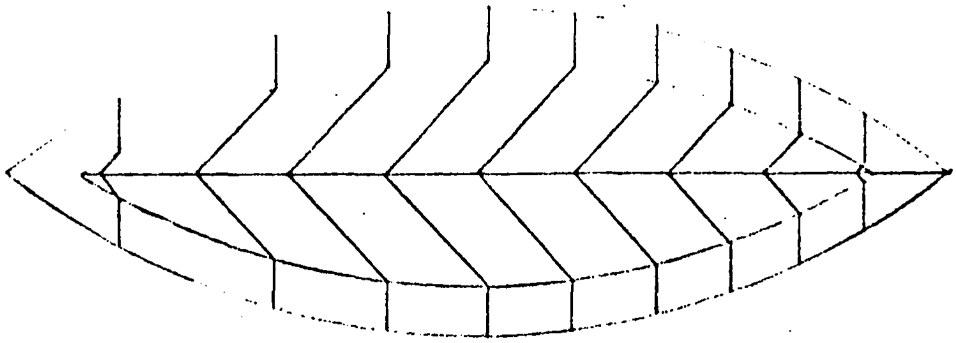

A: I = .576
B: I = .667
C: I = .486
D: I = .585
1.0
.8
.6
.4
.2
0
$\frac{h}{H}$
0
.2
.4
.6
.8
1.0
$\frac{a}{A}$

Figure 6. The hypsometric curves for an idealized basin composed of side slopes and noses for the four arrangements of the contour lines shown in Figure 4.



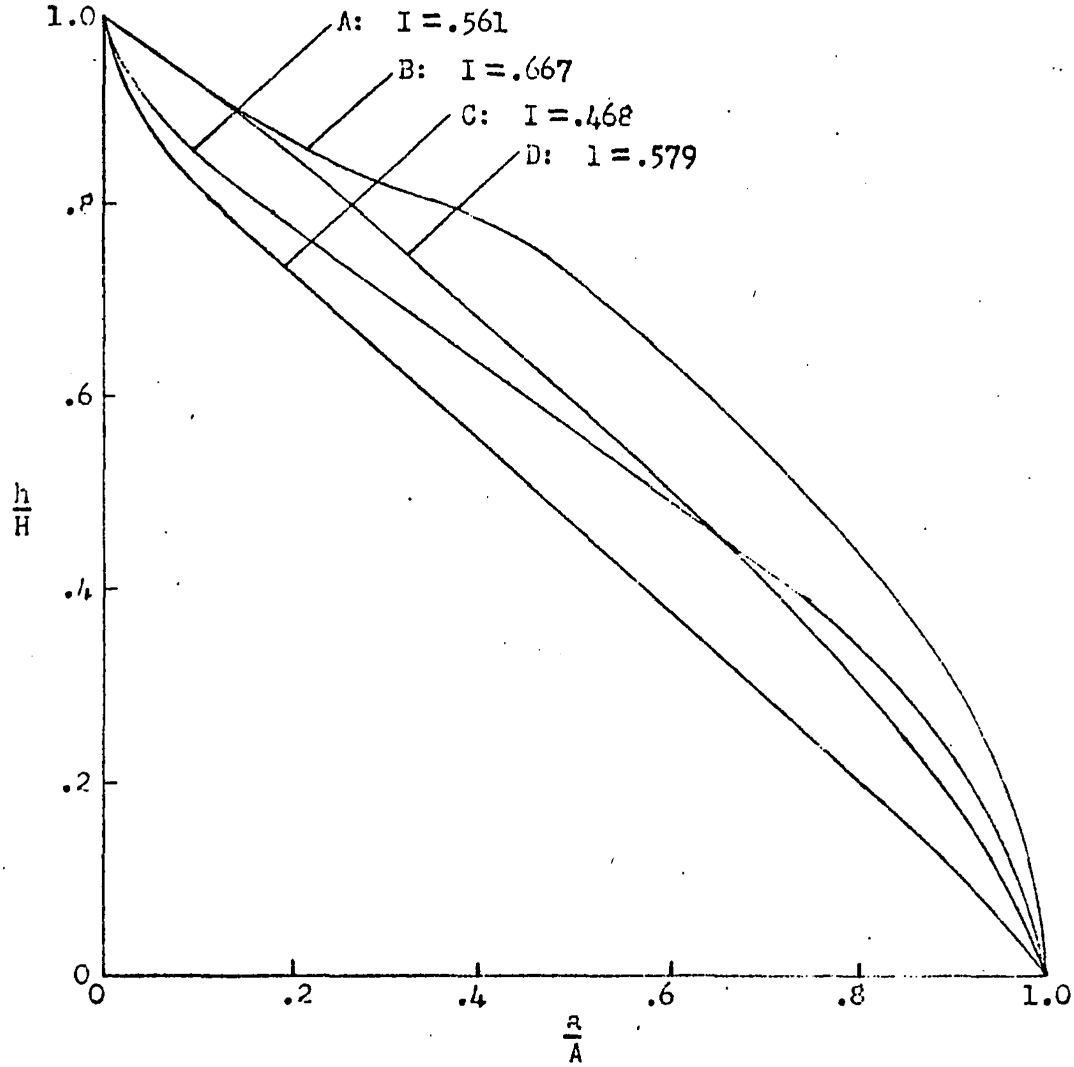
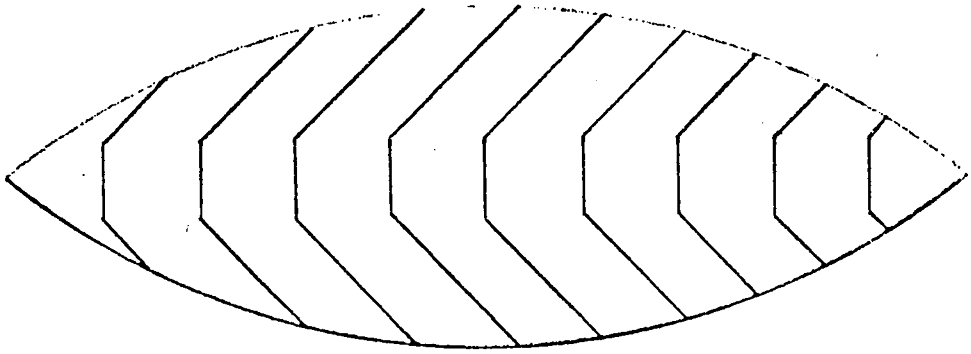

A: I =.561
B: I =.667
C: I =.468
D: I =.579
1.0
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1.0
h/H
a/A

Figure 7. The hypsometric curves for an idealized basin composed of side slopes and hollows for the four arrangements of the contour lines shown in Figure 4.



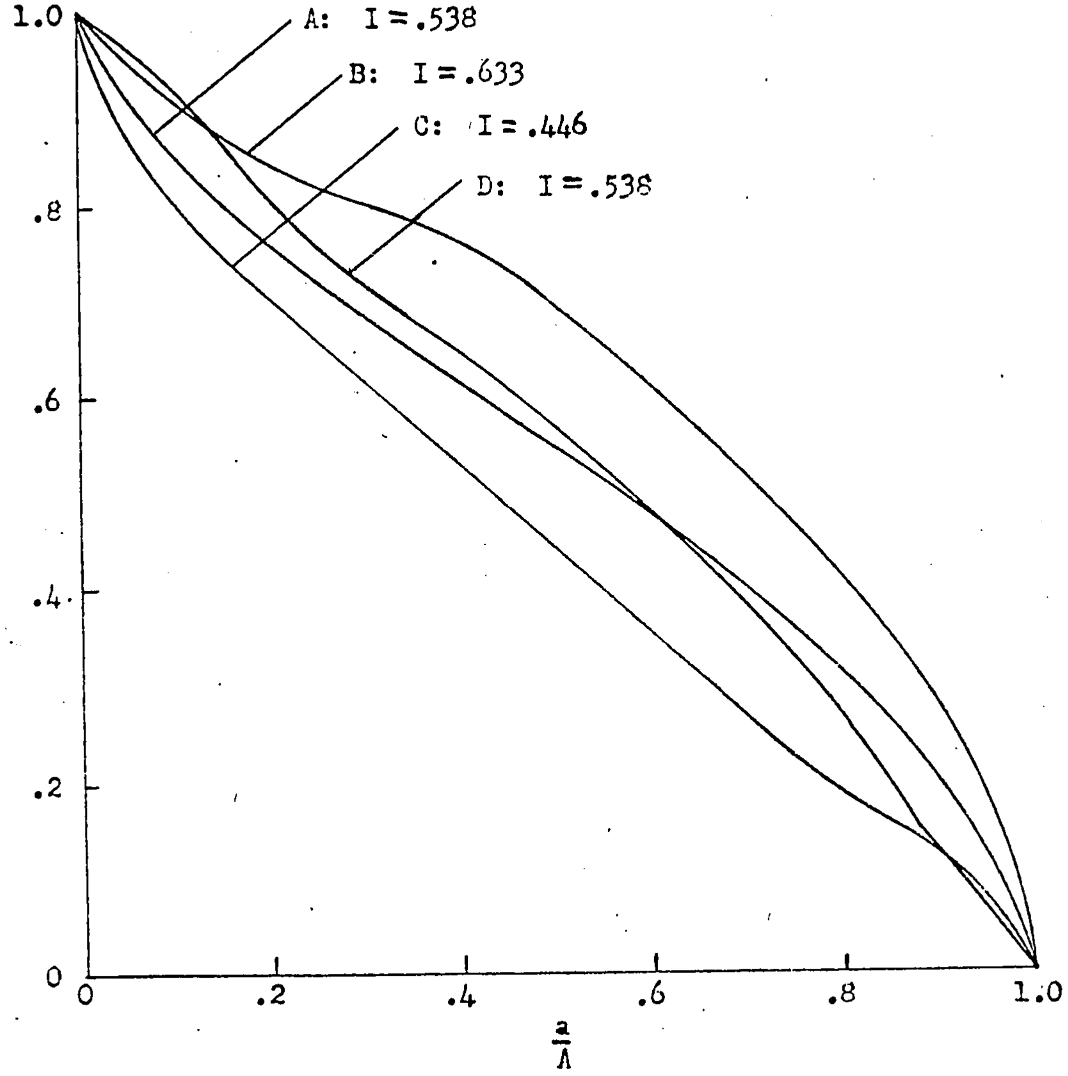
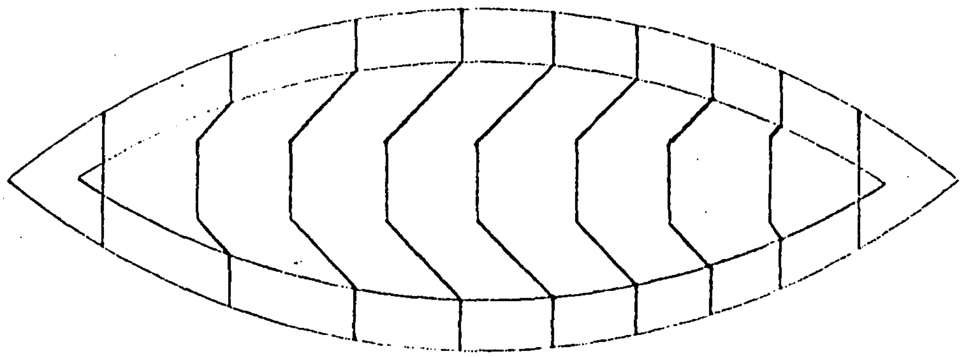

A: I = .538
B: I = .633
C: I = .446
D: I = .538
1.0
.8
.6
.4
.2
0
$\frac{h}{H}$
0
.2
.4
.6
.8
1.0
$\frac{a}{A}$

Figure 8. The hypsometric curves for an idealized basin composed of side slopes, noses, and hollows for the four arrangements of the contour lines shown in Figure 4.



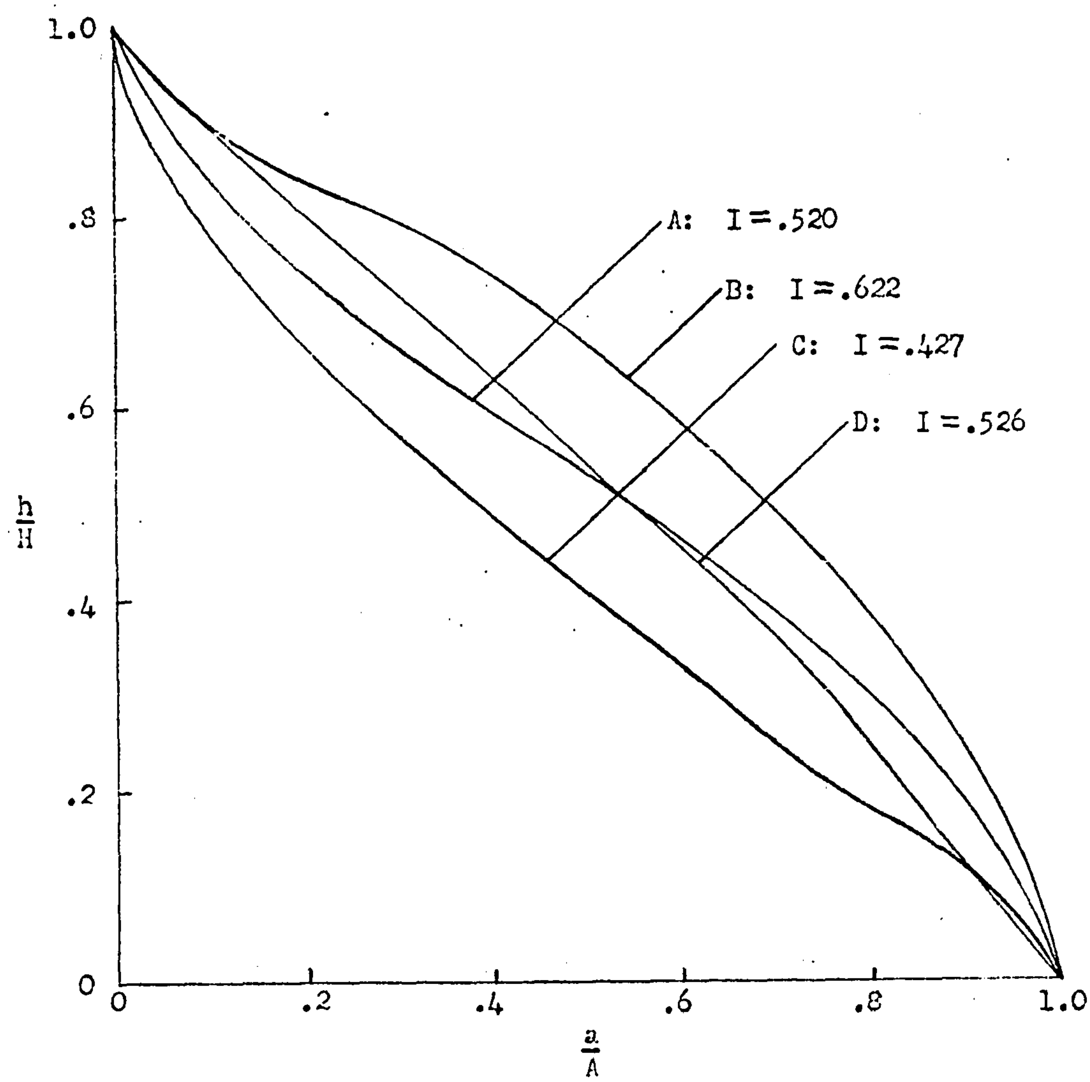
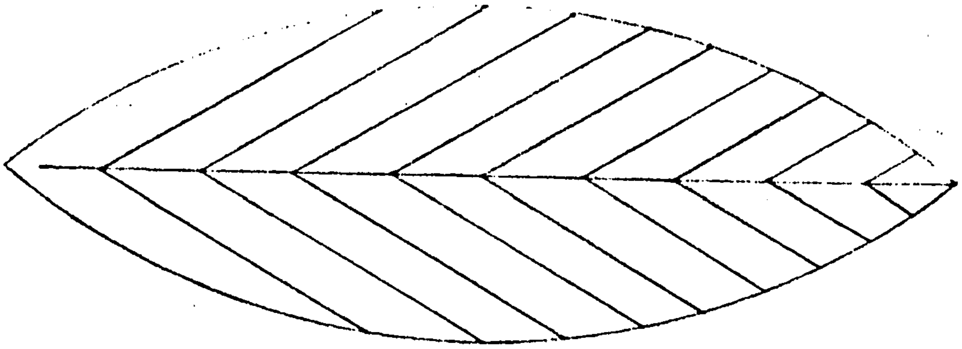

A: I = .520
B: I = .622
C: I = .427
D: I = .526
1.0
.8
.6
.4
.2
0
h/H
0
.2
.4
.6
.8
1.0
a/A

Figure 9. The hypsometric curves for an idealized basin composed entirely of side slopes for which the angle formed by a contour line as it crosses a basin has been changed from the previous examples.



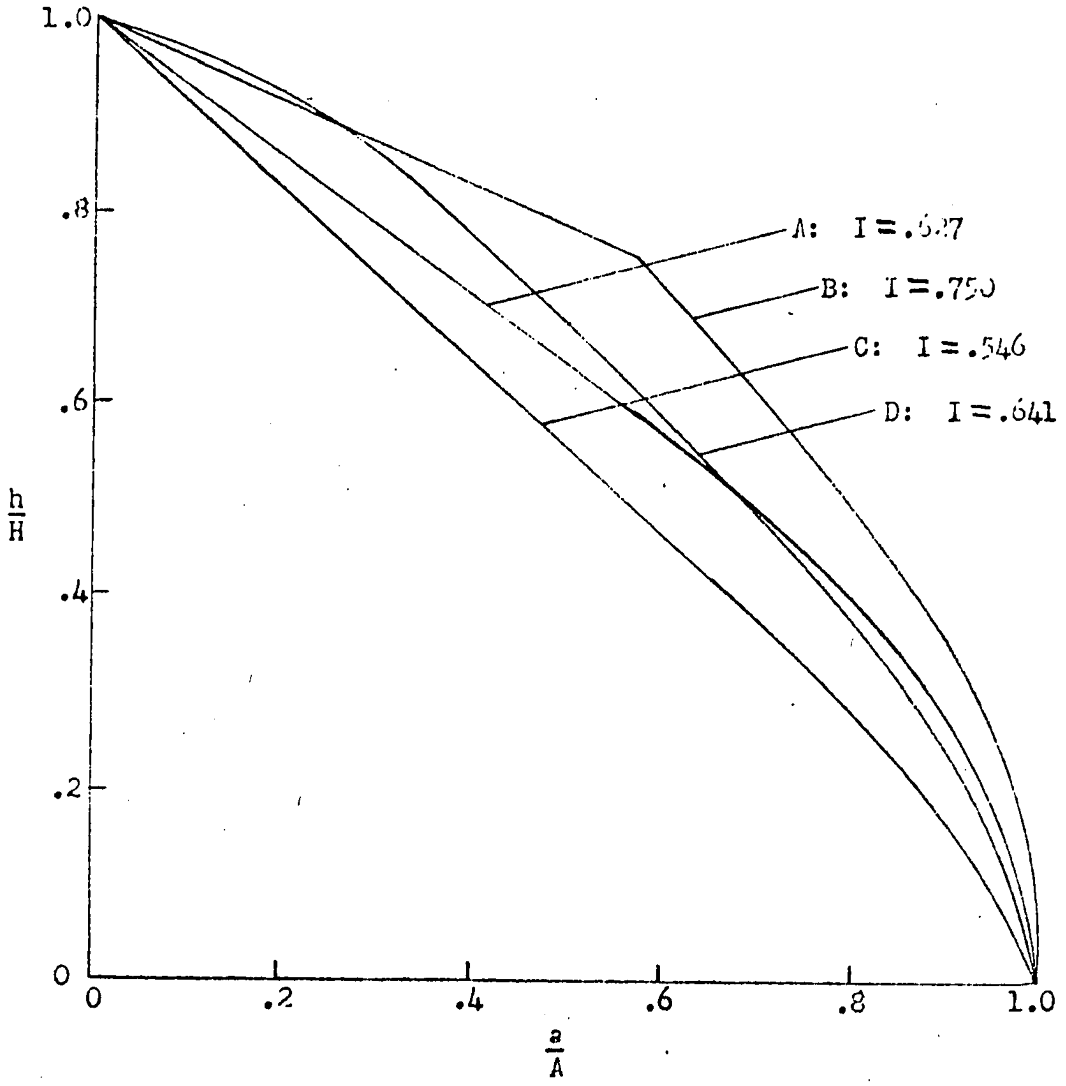
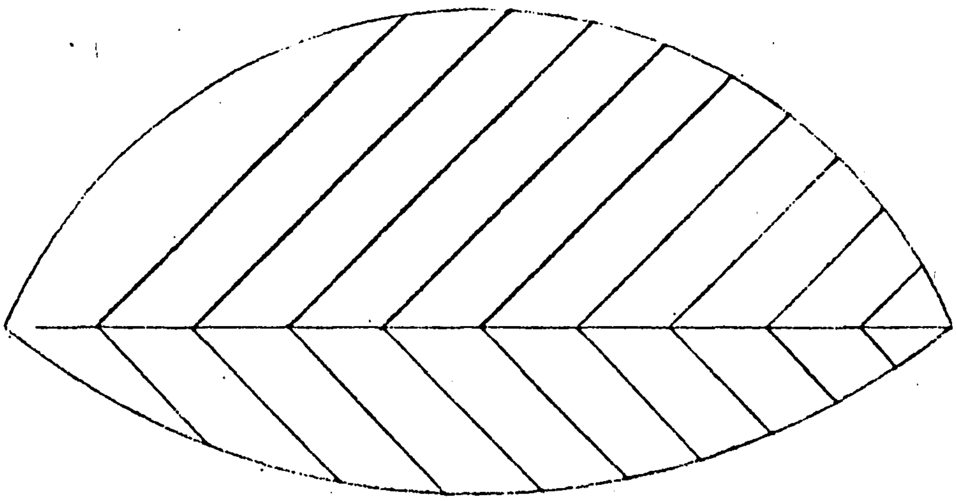
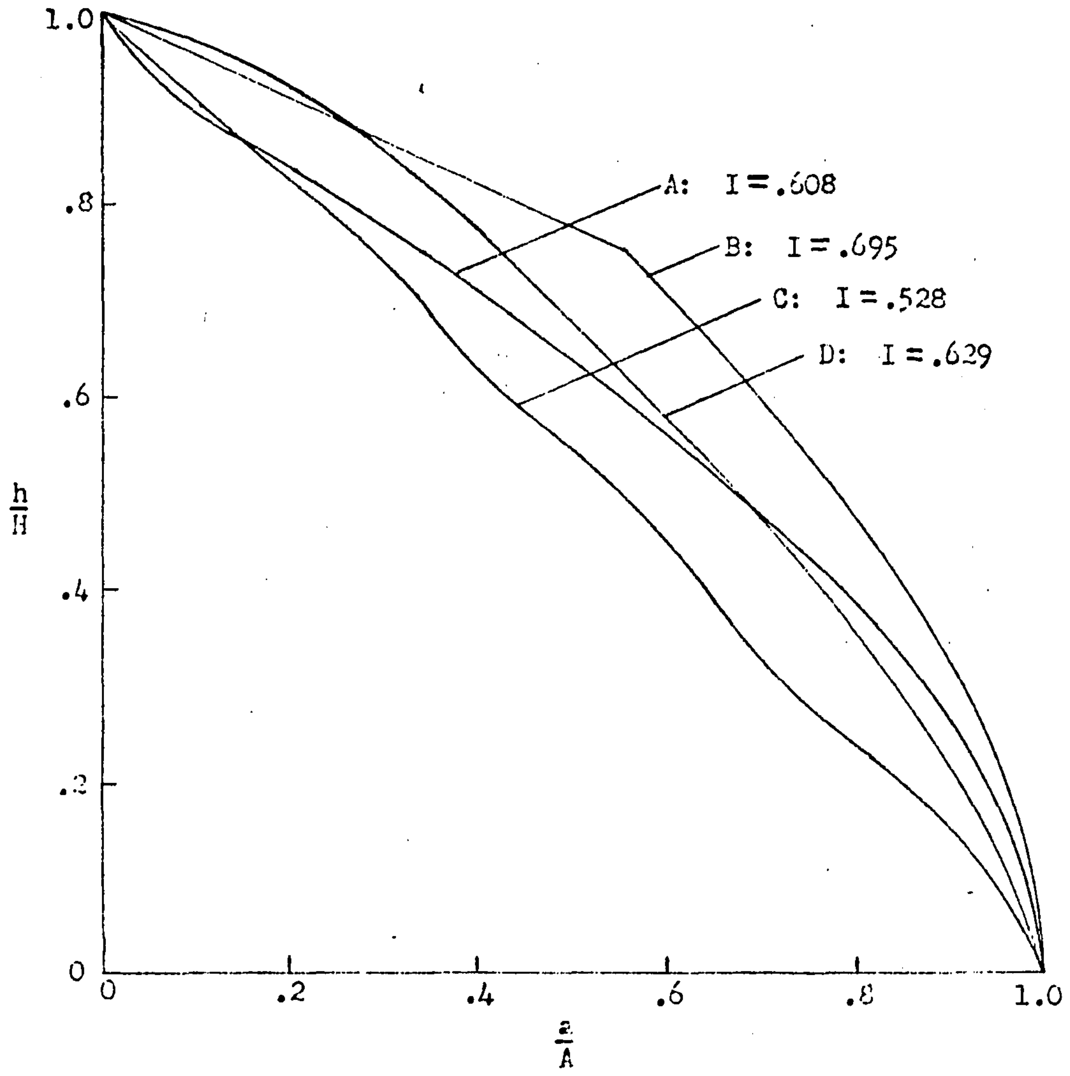

A: I = .627
B: I = .750
C: I = .546
D: I = .641
1.0
.8
.6
.4
.2
0
h/H
0
.2
.4
.6
.8
1.0
a/A

Figure 10. The hypsometric curves for an asymmetrical idealized basin composed entirely of side slopes.




A: I = .608
B: I = .695
C: I = .528
D: I = .629
1.0
.8
.6
.4
.2
0
h/H
0
.2
.4
.6
.8
1.0
a/A

Stage

The hypsometric curve varies through a rather restricted range of forms in response to moderate changes in each of the five factors discussed. Undoubtedly the widest range of forms of the hypsometric curve are induced by the sequential, interdependent changes from inequilibrium stage to equilibrium stage to monadnock stage back to equilibrium stage. In the incipient inequilibrium stage the angle formed by a contour line as it crosses a stream is commonly more acute than has been illustrated in this paper. This angle becomes less acute as the monadnock stage is approached, implying a progressive decrease in I if all other factors remain constant; moreover this angle should continue to become more obtuse as the basin returns to the equilibrium phase with the removal of the monadnocks, yet I will increase. This increase in I is in response to a "rather rapid" change in the distribution of relief in the basin.

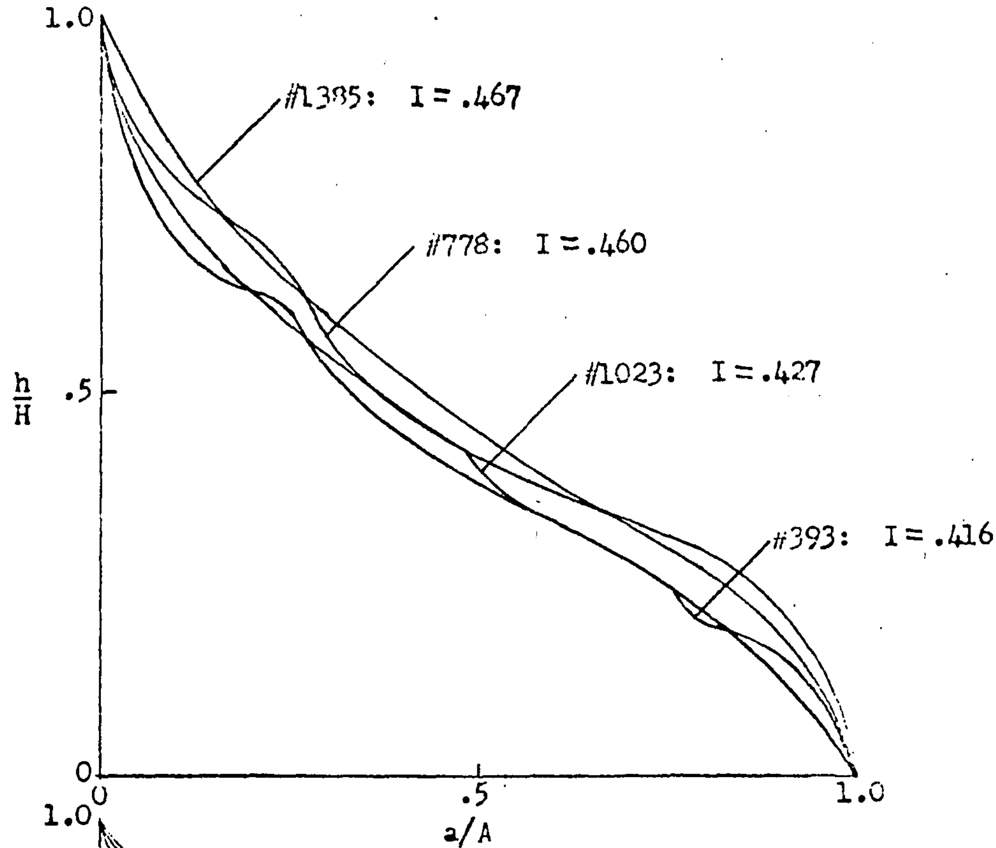
Examples from the Study Area

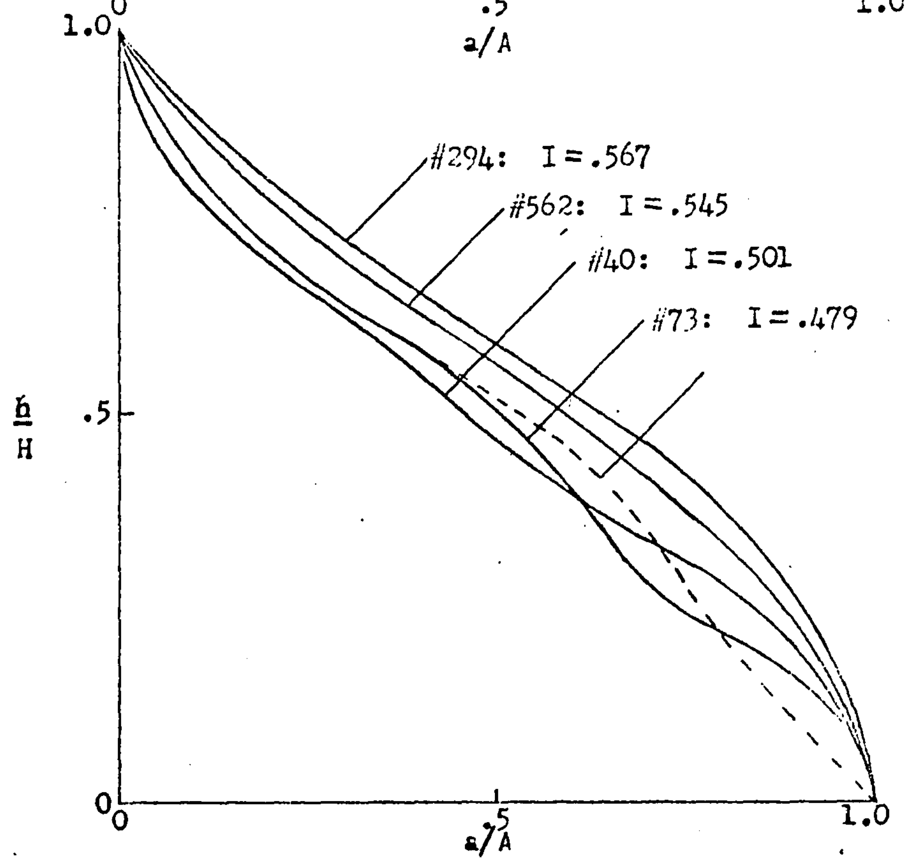
The hypsometric curves of the fourth order basins in the study area can be separated into two groups: (1) those whose hypsometric integral is greater than that of the fifth order basin (Figure 11) and (2) those whose hypsometric integral is less than that of the fifth order basin (Figure 11). The hypsometric integral of the former group increases as the area of the basin increases, and the curves are, in general, quite smooth; whereas the hypsometric integral of the latter group decreases as the area increases and the curves are, in general, more irregular than the former group.

Figure 11. Hypsometric curves for fourth and fifth order basins in the Smoky Hill River drainage basin. Additional data concerning these basins in given below:

Basin #	A	L	D'	l	R	D	F
73	123.3	7.0	98.5	23.7	700	.96	.27
168	209.5	27.4	372.5	34.1	925	1.04	.32
40	390.1	19.0	398.5	44.6	1700	.24	.10
562	650.4	60.0	269.1	74.8	1150	.56	.17
294	712.1	14.4	361.1	82.8	1725	.61	.18
778	185.3	22.2	210.1	26.3	515	.90	.26
1023	861.1	80.6	170.9	104.0	1250	.88	.24
393	1510.5	8.0	528.4	92.0	1250	.29	.04
1385	8534.0	398.5	-	285.2	3550	.61	.16

Basin #	D_R	H	S	Q	k
73	.29	.13	29.5	.30	3.58
168	.29	.18	27.1	.89	4.36
40	1.74	.08	38.1	.76	4.00
562	.52	.12	15.4	.80	6.76
294	.48	.19	20.8	.26	7.56
778	.32	.09	19.6	1.02	2.93
1023	.31	.21	12.0	.74	9.87
393	.45	.07	13.6	.09	4.40
1385	.44	.41	12.4	1.62	7.49


1.0
#1385: I = .467
#778: I = .460
#1023: I = .427
#393: I = .416
h/H
.5
0
0
.5
1.0
a/A


1.0
#294: I = .567
#562: I = .545
#40: I = .501
#73: I = .479
h/H
.5
0
0
.5
1.0
a/A

Much of the area of the former group lies in the Ogallala Formation. This group includes the two order-forming fourth order basins, and basins of three adventitious streams that are on the north side of the fifth order stream. The shapes, k, of all five of these basins vary from 3.6 to 7.5 and increase as the area increases with one exception. Their median relief increases as the area increases with one exception. In this group of basins the interfluves account for a relatively smaller amount of the total relief; whereas the contour lines become much more closely spaced where the streams initially cut into the underlying Cretaceous beds. Basins #168 and 73 appear to deviate from this tendency in the lower reaches because a larger proportion of each basin is in the underlying Cretaceous rocks resulting in a greater flattening of the profile in the lower reaches. Basin #168 becomes quite narrow at the mouth which causes the curve to become concave upward, whereas Basin #73 does not.

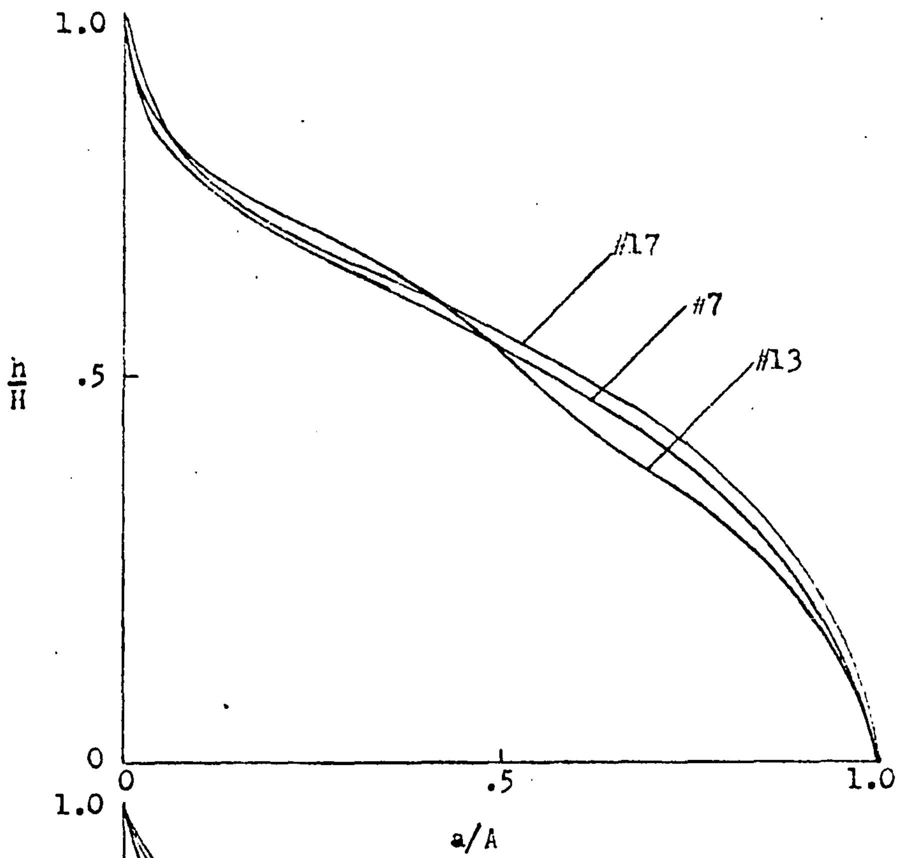
The second group of curves represents areas in which the interfluves appear to account for a larger portion of the total relief. Basin #393 lies almost entirely in the Ogallala Formation, but it becomes quite narrow in the upper reaches and quite broad in the lower reaches, which accounts for the shape of the curves. The stream channels in the lower reaches are deep, but approximately 50% of the area between these streams is undissected uplands. Basin #778 lies almost entirely in the Niobrara chalk beds. It appears that the lower reaches of Basin #778 account for a rather larger percentage of the total relief because the basin becomes quite narrow and the angle formed by the contour lines crossing the stream is extremely acute. The upper half of Basin #1023 is exceedingly narrow and the contour lines are widely spaced, whereas the contour lines become much more closely spaced where the stream cuts into the underlying Cretaceous beds in the middle section. This basin and the separation between contours becomes quite wide in its lower reaches.

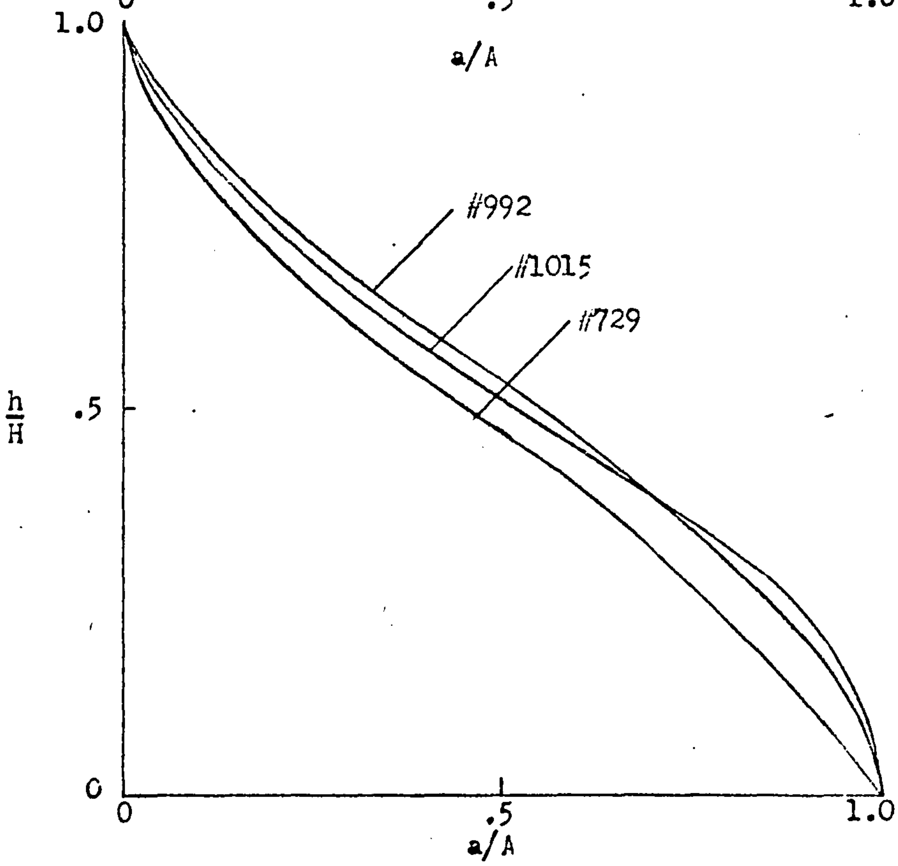
All the preceeding basins discussed were rather large and breached two different lithologies. Two groups of smaller basins that are developed entirely in either the Ogallala Formation or the Niobrara chalk beds are also included (Figure 12). The hypsometric integral increases as the area increases in both groups; exceptions were noted to this tendency. The hypsometric curves for the group of basins in the Ogallala Formation are more S-shaped than those in the Niobrara chalk beds, which indicates that a greater proportion of the total relief is accounted for by the interfluves and the lower reaches of the basin in the elastic sediments than in the chalk beds. This is true of the interfluves but not true of the lower reaches of the basin, perhaps for different reasons in different basins as demonstrated in the following discussion of Basin #7 and #13.

Basin #7 is one of the order-forming second order basins to the trunk of the Smoky Hill River. This basin is roughly delta shaped, and it contains six first-order streams. Three of the four adventitious streams in Basin #7 intersect the trunk on the same side, causing the basin to be asymmetrical, especially in the lower portions. The angle formed by the contour lines crossing the streams remains approximately constant. Two high areas exist on the margins of the basin in the upper reaches, which

Figure 12. Hypsometric curves of basins formed entirely in the Ogallala Formation (upper curves) and entirely in the Niobrara chalk beds (lower curves)

Basin #	I	A	k
17	.539	174.5	3.86
7	.522	65.3	3.08
13	.509	55.0	4.68
992	.526	118.0	3.19
1015	.515	44.0	5.85
729	.467	40.0	3.32


1.0
h/H
.5
0
0
.5
1.0
a/A
#17
#7
#13


1.0
h/H
.5
0
0
.5
1.0
a/A
#992
#1015
#729

is reflected in the hypsometric curve by the concave upward portion of this curve; otherwise this curve would have been expected to be straight. The lower portion of the curve is convex upward, which reflects the narrowing of the basin at the mouth since the distance between contour lines remains relatively constant.

Basin #13 is one of the order-forming second order basins to the trunk of the Smoky Hill River, and it contains five first order streams. Two of the three adventitious streams intersect the trunk on the same side, causing at least the middle part of the drainage basin to be slightly asymmetrical. The overall planar shape of the basin indicates that the centroid of the planar area should be slightly upstream from the mid-point of the basin length. The angle formed by the contours as they cross the stream becomes more acute as the mouth of the basin is approached. The slope decreases quite rapidly in the upper reaches of the basin, which is reflected in the hypsometric curve by the concave upward portion of the curve; this was also true of the curve for Basin #7, but for a different reason. Immediately below this concave portion of the curve is a slightly convex portion that apparently reflects a small area, relatively more flat and undissected than the remaining area downstream; it is not associated with any mapped lithologic change. The lower portion of the curve is convex upward, which reflects the narrowing of the basin at the mouth since the distance between contour lines remains relatively constant.

In summary, if the hypsometric curve and its integral are used as a means to describe the distribution of relief in drainage basins, other parameters, such as basin shape (k is insufficient for this purpose), spacing and arrangement of contour lines, and asymmetry of the basin must be included to allow complete assessment of why the shape of the hypsometric curves and the value of I are as they are.

EXTENDED STREAM ORDERING NOTATION

The results of several morphometric studies at various locations in the United States of America have been published. Since the accumulation of morphometric data is extremely time consuming, it would be desirable to combine the results of these studies statistically to allow broader inferences to be made and to increase the sensitivity of the tests.

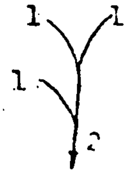
There are several difficulties involved in combining experiments. Only heterogeneous error will be considered here because it demonstrates the need for a different classification scheme of streams. If the results of the various morphometric studies are compared, it is apparent that errors are heterogeneous; in other words a variable that is highly significant in one study may be nonsignificant in another study. There is no reason to expect that all low-ordered drainage basins of the same order will have approximately the same value for their morphometric parameters regardless of their position in the same large drainage basin or in areas with different environments; more desirable would be to have some way of designating streams such that these differences would be apparent.

The approach used in this study was to determine all the possible combinations of streams for a drainage basin of a given order (Figure 13). The designation used in the Figure is to be interpreted as follows:

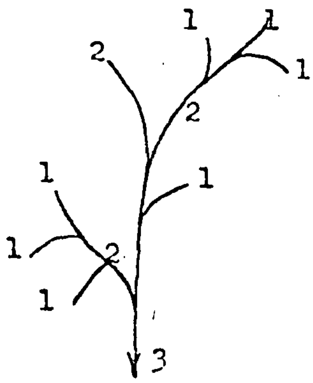
Designation	Interpretation
1-2	A first order stream intersecting a second order stream.
1-1-2	A first order stream intersecting a first order stream to form a second order stream.
2-3-5	A second order stream intersecting a third order stream intersecting a fifth order stream.

Figure 13. This figure illustrates the expanded stream ordering notation for four cases in which the order increases from one to four. It also lists all possible types of streams that may exist for each case. The line drawings illustrating the drainage net are complete for the first two cases. One of the order-forming streams is incomplete for the third case since it would be the same as the one that is shown. Only the possible tributaries that could intersect a fourth order stream segment are shown in the fourth case.

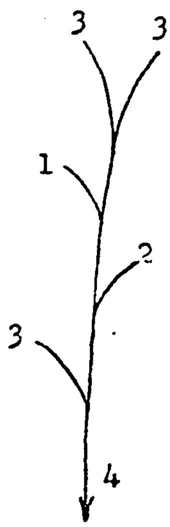
- 1



- 2
  - 1-2
  - 1-1-2



- 3
  - 1-3
  - 2-3
    - 1-2-3
    - 1-1-2-3
  - 2-2-3
    - 1-2-2-3
    - 1-1-2-2-3



- 4
  - 1-4
  - 2-4
    - 1-2-4
    - 1-1-2-4
  - 3-4
    - 1-3-4
    - 2-3-4
      - 1-2-3-4
      - 1-1-2-3-4
    - 2-2-3-4
      - 1-2-2-3-4
      - 1-1-2-2-3-4
  - 3-3-4
    - 1-3-3-4
    - 2-3-3-4
      - 1-2-3-3-4
      - 1-1-2-3-3-4
    - 2-2-3-3-4
      - 1-2-2-3-3-4
      - 1-1-2-2-3-3-4

VARIABLES

General Statement

The morphometric data used in this report were measured on maps of the study area whose scale is 1:250,000. The blue line method was used to designate the order of streams.

It has not yet been determined which morphometric parameters are most sensitive at which map scales, or even if the same parameter at different scales is sensitive to the same phenomena. Several of the variables are considered in semi-detail separately before being combined into an iconic model of a drainage basin.

Variables Treated

The variables are ordered by number, and these numbers correspond to the variable-number in any matrix.

1. Identification, ID_1, of the lithology and the type of basin; each variable contains only five figures, thus it cannot always include the entire designation of the type of basin, i.e. 1 3 3 4 4 5 means that this is a third order basin in lithology one. The remaining numbers of ID will be variable two.
2. Identification, ID_2, includes that part of designation of the type of basin not included in ID_1.
3. Azimuth, Az, is direction of the tone from the center of the basin to its mouth.

4. The straight line distance, B, of a stream segment of a given order measured from the junction of two order-forming streams to the mouth of the next higher order basin. Order-forming streams are streams of the same order, u, that intersect to form a stream of one higher order, u + 1.
5. Latitude is primarily a measure of location, but it may also be a measure of certain climatic elements or surficial elements, such as mean annual precipitation, maximum 30-minute intensity, mean depth of frost penetration, mean annual runoff, isoerodents, and precipitation effectiveness, if the contoured values of these elements are latitudinally oriented.
6. Longitude. The same arguments that apply to variable five, latitude, also apply to longitude. In the Smoky Hill River basin mean, annual precipitation, isoerodents, and precipitation effectiveness contours are normal to the basin orientation.
7. Area, A, of the basin in square miles.
8. Stream length, L, of stream segment of a given order in miles.
9. Measured perimeter, P, of the basin in miles.
10. Distance, D', from the junction of a stream of order s with a stream of order <u>u</u> to the mouth of the basin of order u, where $u > s$, measured along the higher order stream.
11. Basin length, l, is the maximum straight line length of a basin.
12. Maximum relief, R, of a basin measured in feet measured from the top of the highest hill to the mouth of the stream.
13. Bifurcation ratio, R_b, as used in the correlation matrix, will always

apply to one order-lag such that it will equal the number of streams of order one less than the basin under consideration.

14. Length ratio, R_L, is defined slightly different from Horton's (1945, p. 287) definition to be consistent with the ordering system used. In this study it is defined as

$$R_L = \frac{L_u}{\Sigma L_{u-1}/R_b}$$

17. Ratio of the length ratio to the bifurcation ratio, R_{Lb}.

18. Area ratio, R_a, is defined as

$$R_a = \frac{A_u}{\Sigma A_{u-1}/R_b}$$

19. Ratio of area ratio to the bifurcation ratio, R_{ab}.

20. Drainage density, $D = L/A$.

21. Stream frequency, $F = N/A$ where N = number of stream segments.

22. Relative density, $D_R = F/D^2$, is a measure of the completeness with which the channel net fills the basin outline for a given number of channel segments.

23. Ruggedness number, $H = RD/5280$, is a measure of the relative relief of a basin.

24. Declevity, $S = R/l$, is given in feet/mile.

25. $Q = 2B/l$ is a measure of the relationship of the junction of order-forming streams to the center of the basin.

26. The stream length segment ratio, $R_B = B/L$, is a measure of the deviation of stream segment from a straight line.

27. The ratio of the bifurcation ratio to the stream length segment ratio, $R_{bB} = Rb/R_B$.

28. The shape factor, $k = \pi l^2/4A$, indicates that the basin is a circle when $k = 1$, and it becomes more elongate as k increases.

31. The calculated perimeter, Pc, is obtained from an elliptic integral of the second kind using k and ℓ.

32. The lemniscate ratio, Pc/P, is a measure of deviation of the actual shape from the ideal shape.

33 and 34. The ratio of total channel length to basin perimeter, L/P and $\Sigma L/P$, is a measure of the relative development of the channel net within a basin's outline.

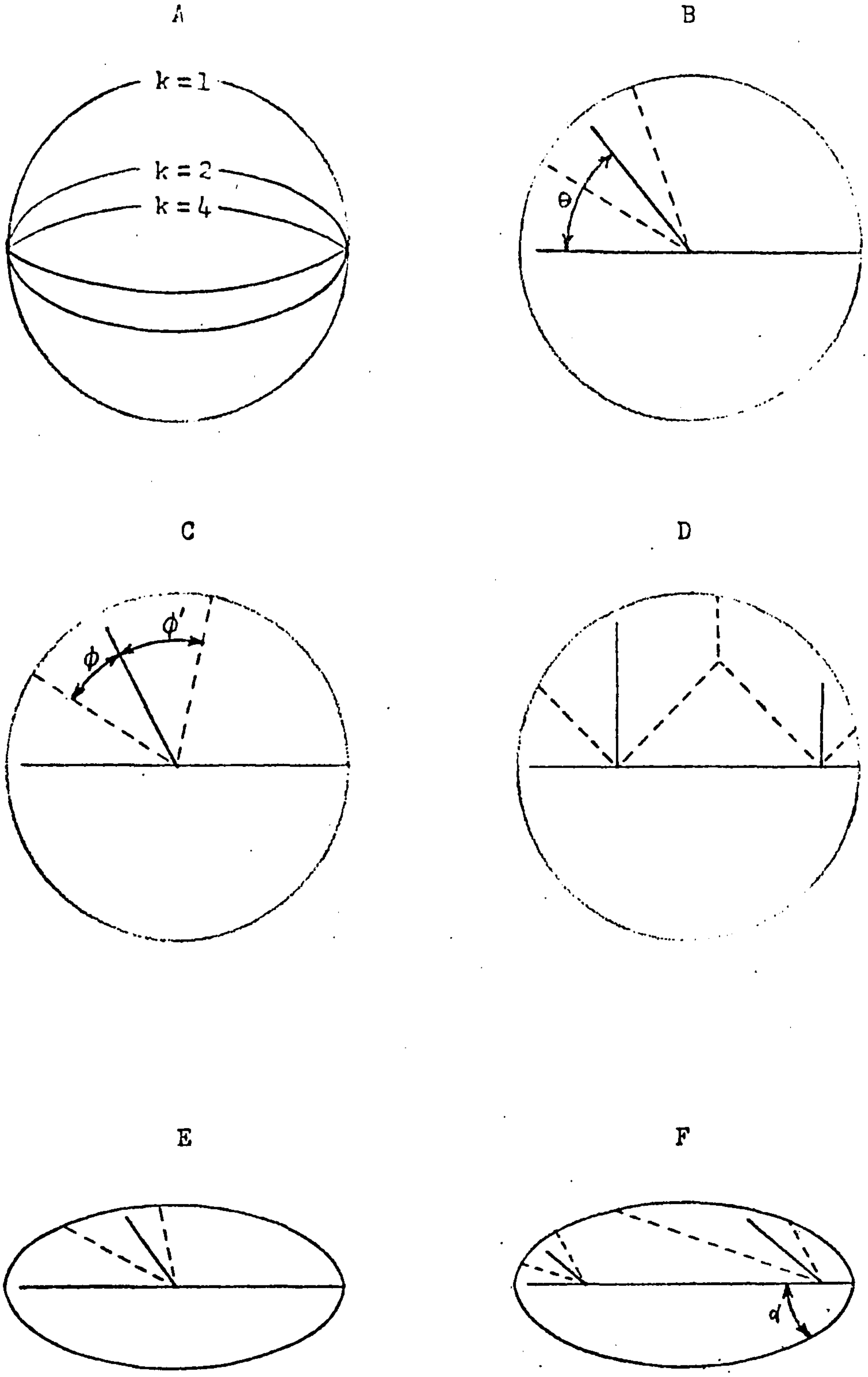
Shape

Chorley, Malm, and Pogorzelski (1957) have proposed using one loop of a lemniscate curve as a measure of drainage basin shape. The equation of a lemniscate curve in radial co-ordinates p and θ is $p = \ell \cos k\theta$, where is the longest diameter of the loop and k is a constant. The value of k gives a visual impression of the shape of the basin and can be easily calculated from the formula $k = \ell^2\pi/4A$, where A is the area of the basin. A basin is circular when $k = 1$, and becomes more elongate as k increases (Figure 14 A). The lemniscate ratio - the ratio of the measured perimeter over the calculated perimeter - is a measure of how nearly the actual drainage basin shape approaches that of ideal lemniscate shape. The lemniscate ratio may be an index of adjustment of drainage basin shape to the ideal shape (Chorley, Malm, and Pogorzelski, 1957, p. 141).

Measures of dispersion of values of k may be used to characterize the regimal tendency of drainage basin shape.

Figure 14. Iconic drainage basin models

A. The relation of k to idealized basin shapes
B. An idealized basin illustrating the effect of varying when $k = Q = 1$
C. An idealized basin illustrating $\emptyset$ and $\emptyset'$
D. An idealized basin illustrating the effect of varying Q when $k = 1$, $\Theta = 90^{\circ}$, and $\emptyset = 45^{\circ}$
E. An idealized basin illustrating the effect of varying when $k = 4$ and $Q = 1$
F. An idealized basin illustrating the effect of varying Q when $k = 4$, and Θ and $\emptyset$ are held constant.


A
B
k = 1
k = 2
k = 4
θ
C
D
φ
φ'
E
F
α

Q is a measure of the relationship of the junction of order-forming streams to the center of the basin. Just as the shape of a drainage basin greatly affects the hydrology of the drainage system, so will the manner and number of joining tributaries. Once the shape of a drainage basin of order greater than one is known, it is desirable to determine how the tributaries are distributed in this basin.

It is possible to refer the location of the junction of two streams to form a higher order stream to the center of the higher order basin. Below the junction of these two streams the tributaries that enter the higher order stream may be of one order-lag or greater and will be called adventitious streams. Horton (1945, p. 342) proposed the use of this term to apply to streams which develop later than the initial stream in an area, that would include one of the two streams that I have excluded from being an adventitious stream. This modification of Horton's term is consistent with his use of a bifurcation ratio greater than two to indicate development of adventitious streams. This consistency results from Strahler's (1957, p. 914) modification of Horton's system of ordering streams. Giusti and Schneider (1965, p. G3) refer to streams of one order-lag as smaller tributaries.

The location of the junction of two streams to form a higher order stream may be referred to the center of the higher order basin by dividing the distance from the mouth of the higher order basin to the desired junction by 1/2. This value, Q, will vary between zero and two with a value of one indicating that the center of the basin is at the junction. Values of Q less than one indicates that the junction is downstream from the center of the basin and vice versa. The greater the deviation of the basin shape or the distribution of the streams in the basin from a symmetrical relationship, the less valuable is the Q parameter in demonstrating the desired relationship.

A Kolmogorov-Smirnov goodness-of-fit test was performed on all the Q values for the second, third, and fourth order basins in the study area to test the hypothesis that the data constitute a random sample from a normal population, N(0.87, 0.18), N(0.86, 0.17), N(0.61, 0.12) respectively. The sample sizes were 253, 44, and 8 respectively. The hypothesis could not be rejected in any case at the one percent level. Any model of drainage basin development should probably incorporate these facts into its structure.

Adventitious Streams

Horton (1945, p. 341) has discussed why adventitious streams occur and the effect of their presence on the bifurcation ratio and length ratio. The number of adventitious streams that occur in any basin should increase as Q increases, other things remaining equal, and it should also increase as k decreases, if the area is kept constant, up to some limiting value controlled by the critical distance, X_c, which is the downslope distance from the crest of the divide to the point where rilling begins. In general the number of adventitious streams that occur in a given basin will be a function of k, Q, l, L, X_c, and θ. The sum of the lengths of adventitious streams in any given basin will be a function of the same variables.

Examples

The previous discussion of basin shape, Q, and adventitious streams will now be summarized using actual examples before proposing a new drainage basin model. In the Smoky Hill River Basin the mean shape factor, $\bar{k}$, and the standard deviation increase as the order increases from two to five; however the coefficient of variation decreases as the order increases from one to four (Table 1). These facts express an expected tendency for basins that are long and narrow to have or to have had greater freedom of extension in either direction parallel to the length of the basin than laterally outward from this direction. If this basin was extending its length primarily by headward extension, it would be expected that a greater percentage of the lower order basins in the lower reaches of the drainage system might approach an end point in headward extension much sooner than those in the upper reaches; however these lower order basins may or may not be more or less free to develop laterally depending on the time of their development and their closeness to each other, all other things remaining constant. The fact that $\bar{k}$ and the standard deviation decreases as the order-lag decreases for streams intersecting the fifth order segment indicates that the higher order adventitious streams had more room to expand laterally than headwardly and that they did not severely interfere with each other and that the interference increases as the order lag decreases.

The higher order streams show an increasingly strong tendency for $\bar{k}$ and the standard deviation to decrease as the order-lag increases. This tendency should also be expected for a long narrow basin, such as the

Table 1. Mean, standard deviation, and coefficient of variation for basin shape (k), lemniscate ratio (V_{32}), and Q

Type of streams	n	$\overline{k}$	S_k	CV	$\overline{V}$	S_V	CV	Q	S_Q	CV
All streams	1375	3.46	1.796	.51	.91	.31	.34			
All 1st order	1069	3.45	1.81	.52	.91	.16	.17			
1-1	505	3.23	1.79	.55	.91	.16	.17			
1-2	240	3.39	2.02	.59	.92	.19	.20			
1-3	182	3.87	1.69	.43	.89	.13	.15			
1-4	52	3.75	1.59	.42	.92	.12	.14			
1-5	90	3.90	1.40	.35	.88	.09	.11			
All 2nd order	253	3.37	1.63	.48	.88	.23	.26	.86	.43	.49
2-2	88	3.45	1.70	.49	.87	.14	.16	.80	.35	.44
2-3	61	3.67	1.97	.53	.95	.41	.43	.80	.45	.56
2-4	33	3.56	1.62	.45	.35	.07	.09	.88	.34	.39
2-5	71	2.93	1.09	.37	.85	.10	.11	.98	.50	.51
All 3rd order	44	3.72	1.78	.47	.80	.09	.11	.85	.40	.47
3-3	16	5.14	2.00	.38	.81	.05	.06	.91	.38	.42
3-4	4	4.15	1.39	.33	.86	.05	.06	.93	.48	.52
3-5	23	2.74	.76	.27	.79	.12	.15	.83	.42	.51
All 4th order	8	5.43	2.39	.44	1.98	3.39		.60	.34	.56
5	1	7.49			.94			1.62		

Smoky Hill River Basin, since the basins with the lower order-lag are more free to develop by extension parallel to the trend of the basin.

The mean lemniscate ratio, $\overline{V}_{32}$, decreases as the order increases from one to three. This fact probably reflects a relatively greater freedom for development on the part of lower order streams as a whole by extension parallel to the basin azimuth. The fact that $\overline{V}_{32}$, decreases and the standard deviation increases as the order lag decreases for streams intersecting the fifth order segment indicates that the higher order adventitious streams were restricted from expanding headwardly and thus assumed a triangular shape with the greatest lateral extension occurring in the upper reaches.

Long, narrow drainage basins indicate that they have, or had, greater freedom to develop by extension parallel to the basin azimuth rather than laterally outward from it; therefore drainage basins of zero order-lag should reflect this tendency as the order increases by a progressive increase in $\bar{k}$ and decreases in the lemniscate ratio. This tendency is present in the study area except that the $\bar{k}$ for the fourth order basins decreases. This decrease could be the result of a decrease in the water-table or interference with another drainage basin which is restricting the headward development of the drainage system. This argument is further supported by the fact that Q for the fifth order basin is high.

$\bar{Q}$ and the number of adventitious streams intersecting the fifth order segment of the Smoky Hill River increase as the order lag increases; $\bar{k}$ increases as the order lag increases, for orders one, two, and three (Table 1). The number of adventitious streams intersecting any given order segment on the average increases as the order lag increases and decreases as $\mathcal{L}$ and $\bar{L}$ increase. These generalities are probably valid for small map scales, but as the map scale becomes larger, will probably become more significant as the critical distance becomes more important. When individual basins are considered, these relationships tend to break down.

The number of order forming basins increases as the order and $\mathcal{L}$

Table 2. Relationship of mean basin length ($\bar{\ell}$), basin shape ($\bar{k}$), stream length ($\bar{L}$), and Q to order lag

Stream type	$\bar{\ell}$	$\bar{Q}$	$\bar{k}$	$\bar{L}$	n
1-5	4.50		3.90	4.31	90
2-5	7.40	.99	2.93	4.69	71
3-5	12.11	.83	2.74	6.59	23
4-5	69.00	.63	5.98	35.40	6
1-4	4.19		3.75	3.93	52
2-4	6.59	.89	3.56	4.38	35
3-4	16.10	.94	4.15	8.33	4
4-4	34.10	.55	3.79	13.00	2
1-3	3.72		3.87	3.07	182
2-3	8.39	.81	3.67	5.22	61
3-3	32.51	.91	5.14	33.93	16
1-2	3.39		3.39	2.85	240
2-2	16.24	.80	3.45	4.94	88
1-1	3.45		3.25	2.97	505

decrease as would be expected. Order is directly proportional to $\bar{L}$ and $\bar{k}$ except for 4-4 streams.

The adventitious streams along the length of the order-segment into which they flow were found to be rather evenly distributed along the length of the receiving stream in all but one case.

DRAINAGE BASIN MODEL

Horton (1945, p. 339) proposed a model for the development of a drainage net in which he assumed a square area with its diagonals parallel with the direction of slope. Horton (1945, p. 341) recognized that differences occur between the development of streams under natural conditions and that of the model. Drainage basin development can also be analyzed on the basis of k and Q.

In the following discussion of an idealized model it will be assumed, unless otherwise stated, that (1) one stream, the trunk, will bisect the ideal basin; (2) a second stream, the tributary, will intersect the trunk at various positions, Q, and angles, Θ; (3) the critical distance, X_c, is constant; (4) all streams are straight; and (5) all tributaries bisect their drainage basins forming an angle, $\emptyset$, with their divides.

Assuming $k = Q = 1$, then as Θ increases up to 90°, (1) $\emptyset$ probably will increase causing an increase in the area drained by the tributary; (2) the basin length, ℓ, of the tributary basin will remain constant up to the point where $\emptyset$ exceeds 30° after which ℓ will also increase as $\emptyset$ increases; (3) the stream length, L, will remain constant; (4) the shape, k, of the tributary basin will decrease as $\emptyset$ increases (Figure 14 B).

Assuming $k = 4$ and $Q = 1$, then as Θ increases up to 90°, the following will probably occur: (1) $\emptyset$ probably will increase causing some initial increase in the area drained by the tributary which will reach a maximum while Θ is relatively small; (2) the length of the tributary basin, ℓ, will decrease; (3) the length of the tributary, L, will decrease; (4) the shape, k, of the tributary basin will decrease (Figure 14 E).

In the preceeding two examples Q = 1 while θ increased from 0-90° for two different values of k. The position of the tributary at which the area it drains is a maximum will be controlled by the rate of increase of $\emptyset$ as θ increases, and the θ at which this occurs will in general increase as k decreases. Horton (1945, p. 349) developed the following equation for stream-entrance angles based on geometrical considerations; $\cos \theta = \tan s_c / \tan s_g$ where s_c is the channel slope of the trunk and s_g is the ground slope, which he assumed to be the same as the slope of the tributary. It would be nice to know $\emptyset$ as a function of θ, preferably in a form such that $\emptyset$ and $\emptyset'$ could both be determined (Figure 14 C).

Assuming k = 1, θ = 90, and $\emptyset$ = constant, then as Q decreases from two to zero, the following would be expected to occur: (1) the area drained by the tributary will increase to a maximum at Q = 1 and thereafter decrease. The area on the upstream side of the tributary will be less than that on the downstream side when Q > 1 and vice versa when Q < 1. (2) the length of the tributary basin, ℓ , will remain constant and equal to the radius of the basin when $\emptyset = 30^{\circ}$; when $\emptyset > 30^{\circ}$ ℓ will equal some constant value greater than the radius of the basin, and when $\emptyset < 30^{\circ}$ ℓ will reach two maxima; (3) the length of the tributary stream will increase to a maximum at Q = 1 and k, of the tributary basin will decrease to a minimum at Q = 1 and thereafter increase (Figure 14D).

Assuming k > 1, $\theta < 90^{\circ}$, and $\emptyset$ = constant, then as Q decreases from two to zero, the following would be expected to occur; (1) the area drained by the tributary will increase, and the upstream area will be greater than the downstream area except when the junction is upstream from the center of curvature of the headwaters portion of the second order basin; (2) the length, ℓ, of the tributary basin will increase as long as $(\theta - \phi) < \alpha$; (3) the length, L, of the tributary will increase to a maximum at some value of $Q < 1$ and thereafter will decrease; (4) the shape, k, of the tributary basin will increase as long as $(\theta - \phi) < \alpha$ (Figure 14 F).

Interference or interaction will occur among drainage basins as the interfluves become more narrow. The degree of interaction is difficult to measure much less predict, except in a very general way. If θ for the adventitious streams increases as the mouth of the higher order basin is approached, the interaction should be at a minimum, and vice versa. Horton (1945, p. 350) has recognized that θ may increase, decrease, or remain constant along the length of a valley, but, generally, θ will increase downstream.

The foregoing discussion shows that there is a strong interrelationship between the following variables; k, ℓ, A, L, Q, θ, ϕ, s_c, and s_g. There are other variables which are probably also related to these variables, i.e. stream order, perimeter, etc. The interrelationship of these variables should be amenable to analysis within the concept of the variable system. Melton (1958) has considered a body of data obtained by measurements of elements of climate, topography, and surface features in mature drainage basins within the concept of the variable system. The object of the remainder of this section will be to examine only the elements of form in terms of the rationale of the variable system. If the form of a drainage basin changes, the corresponding variables in the associated variable systems will also change. This approach will be applied in the analysis of basins regardless of order, of basins of a given order, and of first order basins of increasing order lag. These systems will operate within a framework of feedback controls. In the variable system these feedback controls will be expressed as loops of interrelated variables. These systems will be classified by the type of feedback mechanism operating as the positive-feedback system, the negative-feedback system, or the no-feedback system.

GEOMORPHIC SYSTEMS

General Statement

Geomorphology is the study of the landscape. This is evident from the three Greek roots: geo (=earth), morph (=form), and logos (=discourse). The study of the landscape is the attempt to understand the relationship of landscapes to their environments - where they are, how they exist there, and why they exist there. Geomorphology thus involves the description of the landscape, the kinematics of the landscape, and the dynamics of the landscape.

The environment of the landscape is the sum of all external factors that affect the landscape. If the environment changes in space-time, the landscape must also change. The landscape is the product of its total environmental history.

Geomorphology involves description, analysis, and synthesis. It does not follow that all geomorphologists are describers, analyzers, and synthesizers because each of these aspects of a geomorphological problem involve progressively more general levels of categories, and the level of categories that an individual person finds comfortable varies among individuals. The range of categories with which an individual may work is generally greater among those individuals who prefer the more general level of categories, such that this individual is a synthesizer as well as an observer and experimenter. This individual combines knowledge from many disciplines in an attempt to develop models. These models have characteristics which lend themselves to study by the methods of operations research. These characteristics are complex sets of interacting variables with inputs and outputs operating within a network of feedback controls. Models with these characteristics are called systems.

Let us consider a geomorphic system; a geomorphic system consists of a piece of the landscape and is thus four dimensional. The characteristics of geomorphic systems are complex sets of interacting variables operating within a network of feedback controls. The environment of the system is the sum of all the external factors with which the systems interact and from which they receive or give energy.

Synthesis may be carried on at several levels in geomorphology, e.g. the form element, the form, the landscape. Each of these systems is a reality; and its morphology and interactions should be capable of observation and measurement to varying degrees of accuracy; however the concept of these systems is a mental construct. The complexity of the hierarchial structure and the network of feedback controls probably increases exponentially from form element to landscape.

The Element

The particular element of a landform, i.e. the nose, sideslope, hollow, (Hack and Goodlett, 1960), is a uniform geomorphic entity which represents the elemental geomorphic system.

One particular element is distinct from adjacent elements. At this level of synthesis the geomorphologist is interested in the manner that that particular element interacts with its environment. The elemental geomorphic system is a piece of the landscape composed of soil, geometric form, vegetation, etc., each of which is uniform. In this context it is probably well to visualize the elemental system as changing through time in response to its environment such that its areal extent and form change as well as its individual components. The study of an elemental system is best carried out in a local area using those parameters which will reflect differences from large scale considerations.

The environment of the elemental system, or any system, is composed of all those forces or factors which affect this particular piece of landscape; however, the system does not affect the environment. The first thing that must be done in any study of an environment-system complex is to define the components of the environment and of the system. Analysis of the results of this phase of the study should permit definition of the boundaries of the system within which changes may occur. Hack and Goodlett (1960) have shown that the vegetation, and the form of the element are uniform in several instances for an area in the Appalachian Mountains. If these results may be generalized, the soil and microclimate might also be expected to be uniform. The term soil is used in the genetic sense in this paper. It is tempting at this point to state that the volume of the elemental system is bounded by surfaces at the base of the soil, at the top of the vegetation, and inclosing the area of the element. If, however, the soil of two different, adjacent elements is similar, it might be desirable to remove the soil factor from the system and place it in the environment; on the other hand the similarity of the soil may reflect the possibility that the parameters used to characterize the soil are insensitive to a real difference. It would thus be expected that the components of the different systems, or even the same systems, may or may not differ, indicating that the boundaries of the volume within which changes would be expected to occur also may, or may not, differ.

When a sufficient number of similar elements have been studied they may be compared to and contrasted with each other in a search for spatial gradients. Dissimilar elements may also be compared and contrasted; however, this is at another level of synthesis, namely, the form.

The Form

An individual form is made up of one or more elements. An individual element is geometrically and genetically related to other elements. An example of an individual form is a particular drainage basin which is made up of a nose, a sideslope, and a hollow.

A form may be relatively isolated by large distances from similar forms, such as a monadnock. Such a local form tends to become adapted or adjusted to its environment. Similar forms may develop relatively close to each other, such as a drumlin field, and will be called a form field. Similar forms may develop adjacent to each other, such as the drainage basins of a drainage system; such an aggregation of adjacent, similar forms is called a formal race, the implication being that similar forms develop in similar environments; however, the truth of this statement remains to be determined since in large areas of essentially the same climate it is not known to what extent the development of local populations of a plant species will affect the landform. Forms or elements also may show a gradual but consistent shift in appearance in response to an environmental gradient. Some forms, therefore, may be made up of easily determined formal races or of forms resulting from complex responses to environmental gradients.

The environment of an isolated or single form may or may not include more components than the environment of the elemental system. To understand the form, the interactions between elements must be considered; the relationship among the components of different elements and their environments must be determined.

When a sufficient number of forms have been studied, they may be examined for spatial gradients. Miller and Kahn (1962) have a general discussion of the techniques that may be used for this phase of the study. These techniques may be applied in the examination of the form field or the formal race.

The Landscape

Elements and forms do not exist alone in nature but in association with at least a few, and usually a great many, other forms. These aggregations of forms hopefully are not haphazard aggregations. They should be spatially ordered organizations which utilize energy and material in their operation. Such an aggregation of dissimilar forms is called a landscape.

Any effort to parametize the landscape, especially a large number of landscapes, will demonstrate that the range of the size of landscapes is greater than that of forms, and that of forms is greater than that of elements. The fact that the landscape is an aggregation of dissimilar forms immediately raises the question of how and what to parametize. Since the size of landscape may vary greatly depending upon the scale of the features which are being considered, the microclimate or mesoclimate may be of greater importance than the macroclimate.

The Environment

The environment occupies space-time. This does not mean that the environment is uniform or steady, but only that the environment can show gradients that transgress space-time. These gradients may be made up of several components, which vary in space-time but are often analyzed, out of necessity or convenience, with respect to time only or to space only. These components or movements are: (1) the trend or long-term movements may be either straight (planar) or curved in space-time; (2) cyclical movements refer to long term oscillations about a trend which may or may not follow exactly similar patterns after equal intervals of space-time; (3) irregular or random movements refer to sporadic or spasmodic changes in space-time due to chance events which may possibly be so intense as to result in a new trend or cyclical movement. Space-time is probably best considered in the majority of studies as the dimensions of an environment or system rather than as components of the environment or system.

The environment of a first order mountain range will change in space-time, which implies a change in the number of components of the environment with space-time. The trend is probably toward a decrease in number of components of the environment and in intensity of the components of the environment as the relief decreases. Superimposed on the trend will be cyclical movements on which will also be superimposed certain random movements. The total environment is thus a complex system in itself in which many factors interact not only with the geomorphological system but also among themselves. It is extremely difficult to define the spatial limits of the environment because the flow of energy and material into and out of the environment may be dependent upon factors a great distance away which are also part of the environment. It may be impossible to ever hold one part of the environment constant while changing another part. If the structure and operation of the environment, as well as the system, is to be comprehended it is necessary, at least conceptually, to subdivide it in order to predict what should be measured and studied.

No matter how the environment is subdivided, the subdivision will be artificial to varying degrees depending on knowledge, understanding, and the level in the hierarchial scheme of the system under study. In general one would expect that the more restricted the system, the more restricted should be the environment of that system. Environments are dynamic in that they change through space-time in response to direct and indirect effects of the various factors in a cumulative, cyclic, and random manner. The environment of a system determines the changes in the system, but the system is independent of the environment. It is important to parametize the environment not only so the amounts of the principal components at a given location in space-time can be determined but also so the spatial-temporal gradients can be estimated.

The side slopes in a small, east-west trending drainage basin will have different environments. The temporal-spatial gradients of some of the climatic elements, especially temperature, may vary differently on the north and south facing slopes. These differences may or may not be reflected in the elemental system, depending on whether or not their seasonal pattern transgresses a critical boundary. If this basin was in the rainy tropics, it is possible that no difference in the sideslopes would be recognized; however, in the subarctic the north facing slope may be underlain by permafrost and the south facing slope may be unfrozen. Different vegetation, soil strength, etc. may result in different sideslopes of the same basin.

The environmental components that affect one system may not affect another system. With the above statement in mind, the environmental components are: energy, such as radiation and temperature, precipitation, wind, chemical properties of rain, soil, lithologic substratum, vegetation, man, etc.

It has already been suggested that environmental components may be "critical" in the sense that a small change in the environmental component may change the system drastically. This use of "critical" implies that there is a zone in which no change occurs and that if the limits of this zone are transgressed changes in the system may occur very rapidly. The use of "critical", therefore, implies that a set of feedback controls are operative in the environment-system complex such that change is enhanced or inhibited. If the interval of space-time is large enough, it might be possible to recognize an exponential trend such that the rate of change decreases through space-time. Superimposed on the trend may be a set of cyclical movements that could be dependent on the trend, but the trend would be independent of the cyclical movements. Any random movements should be independent of both the trend and cyclical movements. If the range of random movements is extremely large, it may completely mask any trend. If the interval of space-time is too narrow, the trend and the cyclical movements may be confused.

Geologists have long recognized that different geomorphic processes produce different landforms and that the effect of time may mask any evidence of structural control. It was in this context that the concept of morphogenetic regions was proposed. This concept requires that under a certain set of climatic conditions, especially temperature and precipitation, a particular geomorphic process will dominate the sculpturing of the landscape resulting in a unique landscape that can be distinguished from those formed under a different set of climatic conditions. Peltier (1950) has proposed nine such regions. This concept is closely associated with the environment-system complex at the landscape level. The Koppen system of classifying climates is based on temperature and precipitation and has a strong relation to vegetation; thus it might be possible to also apply it to the environment-system complex at the landscape level. The Koppen system is a generalization of two specific techniques for evaluating the effect of total environments, both of which may be applied, perhaps with some modification, in evaluating the environment-system complex.

One approach would be to follow the movement of energy through the environment to determine the amount and disposition of the energy entering and leaving the environment-system complex by applying the energy-budget concept (Geiger, 1957). This approach might be combined with a modification of Langbein's (1964) approach in analyzing the geometry of river channels so that it could apply to the total environment-system complex in which he postulates that the adjustment is toward an equable accommodation of changes in stream power. In this context the environment-system complex in accommodating a change would change its components. These changes would tend to be as uniformly distributed among the components as is permitted within the network of feedback controls. In developing the landscape, the active processes tend toward equal power per unit of area and toward a condition of minimum work. As the landscape tends toward one of these conditions, the other is deprived of fulfillment; therefore the landscape would be expected to occupy an intermediate position.

The second approach is to use the structure and rate of change in vegetational composition through space-time as an indicator of the total environment. It takes time for the vegetation to change in response to a change in the environment-system complex; this fact may be a help or hindrance depending on the nature of the problem. It is difficult to express this approach quantitatively.

Ranges of Geomorphic Systems

The volume of a geomorphic system may change in space-time. If the volume of the system changes, it may be in response to an environmental change or to a developmental change. The volume may change such that the areal extent increases or the vertical extent increases. The areal range of the system is the areal extent in which the system does occur. The possible areal range of the system is the area in which it might possibly occur. The difference between these two ranges represents the area into which the system may expand, or contract which is a prediction in space-time.

The boundary between two landscapes may be abrupt or gradual. In the latter case it is necessary to recognize temporal-spatial gradients such that there is a gradual transition from one landscape to the next, which implies that there is a core in each landscape where the properties of each are best displayed. In this context it would seem that the components of the system and their environments, the range of these components, the direction of causality among components, and the intensity of interaction among components will determine the areal and vertical range and possible range of the system. Once all of these factors have been determined for a variety of systems and their environments, it might be possible to predict the environment of a geomorphic system by examining the spatial organization of the elements, forms, etc. in the unknown system.

The fundamental building block of the landscape is the element. The element is a system whose ability to operate in a given range of environments is determined by the conditioning of the environment itself. Each component of the element and each element has its own range. All elements have some degree of ability to operate in different environments even though their appearance may change somewhat in response to different environments. It is thus important to know the possible range of each component of the system, for this knowledge will allow the predictions of the possible range of the system itself. These predictions would be based on the uniformity and steadiness with which systems and their environments operate today. The more accurate the knowledge of past environments and the prediction of future environments, the more accurate will be the estimates of the operation of the system in the past and the future.

If the range and the possible range coincide, the areal boundaries are steady. This condition does not necessarily imply that the system as a whole is in a steady-state condition for which the rate of inflow and outflow of energy and material is constant. Developmental and environmental changes may still be going on in the system; however coincidence of the range and the possible range may represent some degree of attainment of the uniform-steady state.

Sampling

If one proceeds on the assumption that geomorphic systems are not distributed randomly in nature, the question arises of which systems to study. Since it is impossible to study all systems or even all systems in one class of systems, which result in a distinctive appearance of some portion of the earth's surface, the problem is inherently statistical. What is desired is a description of the structure of the system by sampling a small portion of it. Sampling techniques need to be developed or adapted to fill this need. Some techniques used by geographers, or by people working in the overlap area between geography and some other discipline, such as ecologists, may be adapted, such as sampling by plots, by plotless point methods, and by transects. The sampling technique must provide regional coverage without neglecting local variability.

Mapping presupposes some degree of classification. Before the systems may be mapped, the systems have to be recognized. It might be desirable to group the systems into several relatively homogeneous varieties before examining the relationship of components to each other.

Conditions of State

It has earlier been stated in this paper that space-time are best considered as the dimensions of the system, rather than as components of the system. It is also possible, at least theoretically, that the environment and the system are not independent of space-time; therefore space-time is a component of the system. These two statements appear to be contradictory. The dimensions of the system, however, may change in space-time just as the components of the system and of the environment may change in space-time. A system is steady if the system does not change with time or it can be assumed to be constant during the time interval under consideration. A system is uniform if the system does not change through space or if it can be assumed to be constant through the space interval under consideration. Three examples will be used to demonstrate these possibilities. First, if the dimensions of the system change in response to a change in system such that no further changes result solely from this change in the dimensions then the dimensions act as a dependent variable. For example, if an extra increment of energy is added to a system, such as a drainage basin that is in the steady-uniform state, this energy must flow through the system, and the system must respond to it. The system will respond within the framework of the feedback controls operating within the system, setting up a sequence of changes in the system such that the boundaries of the system change, but the change in the boundaries, by themselves, do not cause other changes in the system. Second, if the dimensions of the system are dependent on the system, and the system is dependent on the dimensions, then the dimensions are components of the feedback mechanism operating within the system. Third, if the dimensions of the system are independent of the feedback mechanism operating within the system, and the feedback mechanism is also independent of the dimensions of the system, then the dimensions of the system act as independent variables.

There exist four possible conditions of state for the environment-system complex depending on whether or not the complex is independent and/or dependent of space and/or time: (1) uniform-steady, (2) uniform-unsteady, (3) nonuniform-steady, and (4) nonuniform-unsteady. Uniform and nonuniform refers to space, for example the relief may be uniform, i.e. constant, or nonuniform, i.e. not constant, over the space interval under consideration. Steady and unsteady refers to time, for example the relief may be steady, i.e. constant, or unsteady, i.e. not constant, over the time interval under consideration. It is possible for the system and its environment to be in different conditions of state because of relaxation phenomena.

The system represents an interval of space-time within which changes can occur. The geomorphologist is restricted in his observation of existing landscapes by measurements, which, in the majority of cases, show no change within the interval of time of the observations; this amounts approximately to observations at an instant in time. In the majority of cases, therefore, a geomorphic system represents a volume. From theoretical considerations the dimensions of this volume may be independent of, dependent on, or a component of the system. This volume may, thus, be considered the little "black box" for which the rate of inflow of energy and material is equal to, is greater than, or is less than the rate of outflow of energy and material. A fourth case would be when there is no inflow or outflow of energy and material into or out of the "box".

If a system is considered which progressively changes from one which initially has a large rate of inflow and a small rate of outflow of material to one which has a small rate of inflow and a large rate of outflow of material, initially the volume of the system would be increasing. With time, the rate of increase of volume would decrease to zero and thereafter become increasingly negative. If the hypsometric integral remained not only constant but the shape of the hypsometric curve did not change, it might be tempting to conclude that the system is in the steady state when in reality the system was only in the steady state when the rate of increase of volume decreased to zero. If, however, several forms are being considered and their hypsometric curve and integral are the same at some particular instant, it could be concluded that they were in the uniform state, but on the basis of this information alone it could not be stated with certainty whether it was the uniform-steady state or the uniform-unsteady state. It is impossible to recognize the steady state by measuring spatially sensitive variables.

Method of Interpretation

Thirty variables have been measured or generated for each of 1375 individual basins in this study area. The 1375 individual basins comprise all the drainage basins in the study area. It is desired to group these basins in such a meaningful way that clusters of highly associated variables in each of these groups may be extracted to explain the significance of the groups and the clusters. The association will be measured by the correlation coefficient, r.

There are several ways in which the 1375 individual basins may be grouped. First, the Q technique (Miller and Kahn, 1962, p. 299) could be applied to all 1375 individual basins. The Q technique correlates two individual basins on the basis of the variables and would result in a 1375 x 1375 matrix. Aside from the fact that a matrix of this size is unwieldy, cluster analysis should result in groups of basins that are highly intercorrelated or linked. It would be interesting at this point to compare these groupings with the order of the basins to see what degree of association, if any, existed. The second method by which these 1375 individual basins could be grouped would be by order alone or by the expanded order notation proposed in this paper or any portion of the expanded order notation using the Q technique. Use of the second method in the search for highly intercorrelated groups of basins assumes that basins of the same order whether the expanded notation is used or not, are highly intercorrelated.

Once the basins have been grouped, the variables within groups are arranged into highly intercorrelated sets of variables. The R technique is used in this case to assess the degree of association (Miller and Kahn, 1962, p. 293). The R technique is based on the measurement of two variables at a time and, for this study, would result in a 30 x 30 matrix.

The Q and R techniques both result in a matrix of correlation coefficients from which factors or clusters may be extracted. The term factor is reserved by some authors (Miller and Kahn, 1962, p. 295) for vector techniques in which the correlation between two variables is represented by vectors, then the correlation coefficient is equal to the cosine of the angle between the two vectors. Melton (1958, p. 442) has defined a factor as a set of many elements that form a complex unity in nature, whereat an element is a particular feature of a phenomenon or process that possesses recognized individuality and that can be measured on a simple linear scale where that measure is a variable that may assume values. The methods of extracting intercorrelated groups from the matrix of correlation coefficients, r, is referred to as cluster analysis. The advantage of cluster analysis is that comparisons can be made from one study to the next (Miller and Kahn, 1962, p. 295) and the worker is continually in close touch with the original variables. It is believed that in this study these advantages outweigh the reduction of the number of variables that results from factor analysis. Cluster analysis is commonly used as a prelude to factor analysis.

There are several methods available for extracting clusters (Miller and Kahn, 1962, p. 295), and one method for extracting correlation sets (Melton, 1958, p. 449) from the correlation matrix. The building of correlation sets is a type of cluster analysis; however the two terms will be used throughout this paper to avoid confusion of the techniques. Before commenting on the differences between the procedures used and on the procedures themselves, a summary of the problem up to this point is in order:

1. Thirty variables have been measured or generated for each of 1375 different individual basins.
2. These basins vary widely in size, shape, and internal arrangement of their streams.
3. The association between any pair of variables for a great number of basins may not be linear.

4. The basins have been grouped using the Q technique which correlates two individual basins on the basis of the variables and cluster analysis.
5. The population frequency distributions are, with one exception, unknown; nonetheless since this is an exploratory study the correlation coefficient, r, will be used.
6. The variables probably cannot change without involving changes in other variables and in the basins.
7. The association between any pair of variables may not be linear because as the space involved increases the variables may change from dependent to linearly independent.
8. There exist varying degrees of a priori knowledge about the causal relations among the variables.
9. The variables in each of the groups of basins may be grouped using the R technique which correlates two variables on the basis of the basins and cluster analysis.

Melton's (1958) technique for extracting correlation sets from the correlation matrix consists, first, of reducing the matrix to only those values which are significantly greater than zero. The test of H_o: p=0, H_A: p=0 can be made at sight using a table of significant r values like that given in Snedecor (1956, table 7.6.1, p. 174). The reduced matrix is examined for possible basic pairs and correlation sets. A basic pair has the reflexive property that each member of the pair is more highly correlated with the other than with any other variable. The basic pair is the nucleus of a correlation set. The other elements of the correlation set are found by looking through the values of r for each variable not contained in one of the basic pairs and adding any variable whose maximum correlation is with one of the variables in the basic pair. The process is cumulative, and, after adding a variable, the list must be scanned again to see whether another variable has its highest correlation with the variables just added.

A cluster is a group of intercorrelated variables such that the correlation between all possible pairs of variables which are members of the group is greater than or equal to some arbitrarily selected level of correlation (Tryon, 1939). Two variables are said to be linked if their correlation coefficient exceeds some arbitrary value. Clusters can be extracted by the ramifying linkage method (Miller and Kahn, 1962, p. 295). These clusters may overlap each other to a considerable degree and will be referred to as maximum clusters. The maximum noncontained clusters may be obtained from the maximum clusters by eliminating those clusters that are completely contained through its members in a larger cluster. Any remaining overlaps may be reduced by the p-F technique (Miller and Kahn, 1962, p. 305). The end result is a series of measurements which cluster around a basic pair. The assumption is made that a pair of morphological measurements which have a high correlation coefficient will indicate a high degree of morphological integration and also that the measurements that cluster around the basic pair will be highly integrated.

The correlation sets or the clusters are often related by intercorrelations of some of their members. These relations can be displayed in a diagram. The diagram of correlation sets and the cluster diagram may or may not convey essentially the same picture of the correlation structure depending on the level of correlation used to define the linkage between variables. Melton (1958, p. 453) believes that there is a basic difference between the two diagrams, whether it shows or not, in that the diagram of correlation sets is a statement of fact about the particular sample at hand; whereas the cluster diagram constitutes a hypothesis about the true correlations among the variables and is evidence of interaction of its members. In this paper the clusters at several levels of correlation will be shown along with the correlation sets (Tables 3 and 4). These tables will be interpreted later. The diagrams of the correlation sets or cluster are not an adequate explanation of the effects of various elements on one another.

The reduced correlation matrix may be interpreted within the concept of the variable system proposed by Melton (1958, p. 443): a variable system, V, is an abstract set of variables such that (a) each is, in reality, rather highly correlated with every other one; (b) the direction of causality (if any) between each pair of variables is stated; and (c) one or more variables in V may be correlated with variables not in V. The variable system constitutes a hypothetical statement about the variables included in the system whether the variables are included in the correlation matrix or not; this is largely an inductive process. The *a priori* knowledge regarding the causal relationships is coded in a diagram by using arrows, lines, and signs. The direction of causality means only that, all other variables being constant, the change will be in the direction indicated by the arrow. As used by Melton, the variable system represents a hypothetical statement about the temporal sequences of changes in variables that can be inferred from the nature of the elements.

Table 3. Reduced maximum noncontained clusters for r significantly greater than zero and correlation sets

Order	Basic pairs	r	Correlation sets	Reduced maximum noncontained clusters
	1-6	.33	/2 1-6-3	4-7-8-9-10-11-12-13-14-17-18-19-23-25-26-27-31
	4-8	.97	7-4-8	1-6-9-10-11-12-13-14-17-18-19-23-25-26-27-31
All	11-31	.99	/23-28 9-11-31-12-10	4-7-8-9-10-11-12-13-14-17-18-19-20-21-24-25-26-27-28-31
orders	13-27	.95	13-27	
	14-18	.91	14-18	9-11-12-13-14-17-18-19-23-25-27-28-31-32-34
r .081				
	25-19	.91	/17-5 25-19-26-33-22	9-11-12-13-14-17-18-19-20-21-22-23-24-25-26-27-28-31
	20-21	.71	20-21-24	11-12-13-14-17-18-19-20-21-24-25-26-27-28-31-32-34
	32-34	.68	32-34	32-33-34
	1-6	.34	/2 1-6-3	1-2-6
All first	11-31	.99	/7/12-10 11-31-9-8	7-8-9-11-12-20-21-22-23-24-28-31-32-33
order	20-31	.70	24-23-20-21-32 28/	7-8-9-10-11-12-20-21-22-23-24-31-32-33
r .081	22-33	.59	22-33	8-9-10-11-12-20-21-22-23-24-28-31-32-33
	4-8	.98	4-8	1-2-5-6
	5-6	.70	5-6-2-1	4-7-8-9-11-12-13-14-17-18-19-20-21-22-23-24-27-31
All second	11-31	.99	/7 /3 24-11-31-12-10 9/	5-6-22-23
order				
	13-27	.87	13-27-26	7-9-11-12-20-21-22-23-28-31
	14-18	.92	14-18	10-13-14-17-18-19-20-21-22-23-27

Table 3. (Continued)

Order	Basic pairs	r	Correlation sets	Reduced maximum noncontained clusters
All second order continued				
r .164	17-19	.84	17-19	11-25-31-33
	20-21	.76	20-21	13-14-17-18-19-20-21-22-23-25-27-33
	22-23	.50	22-23	32-34
	25-33	.77	25-33	
	32-34	.60	32-34	
	4-8	.99	4-8	4-7-8-9-11-12-13-14-18-23-27-28-31-
			/9-7	33-34
	11-31	.99	10-28-11-31-12-6-2-5	6-7-9-11-12-28-31
All third	13-18	.96	27-13-18-23-34-22	20-21-24
order	14-33	.91	14-33-25	14-17-19-33
r .385			26	
	17-19	.76	17-19	14-25-33
	20-21	.65	20-21-24	
	3-5	.92	3-5	3-5
	4-8	.98	4-8	4-8-18
All fourth	6-10	.97	6-10	6-10
order	11-31	.99	11-31-7	11-31-7
	9-28	.93	9-28	9-28
	13-27	.97	18-13-27	13-27
r .834	14-17	.85	14-17	14-17
	19-25	.94	19-25	19-25
	20-21	.97	20-21	20-21
	32-34	.99	32-34	32-34

Table 4. Reduced maximum noncontained cluster for r >.60 and r >.80

Order	Basic pair	Reduced maximum non-contained clusters r >.60	Basic pair	Reduced maximum non-contained clusters r >.80
All orders	4-8	4-7-8-9-11-12-31	4-8	4-7-8-9-11-31
	11-31	13-27	11-31	13-27
	13-27	14-17-18-19-25-26	13-27	14-18
	14-18	20-21	14-18	17-19-25
	19-25	32-34	19-25	
	32-34			
All first order	11-31	7-8-9-11-31	11-31	7-9-11-31
	20-21	8-9-11-12-31		8-9-11-31
		20-21		
All second order	4-8	4-7-8-9-11-12-31	4-8	4-7-8-9-11-31
	5-6	5-6		
	11-31		11-31	9-11-12-31
	13-27	13-27	13-27	13-27
	14-18	14-17-18-19	14-18	14-18
	17-19		17-19	17-19
	20-21	20-21		
	25-33	25-33		
All third order	4-8	4-7-8-9-11-12-13-18-23-27-31	4-8	4-7-8-9-11-12-31
	11-31	9-11-12-13-14-18-23-27-28-31-33	11-31	13-18-27
	13-18	14-17-19-25-33	13-18	14-33
	14-33	20-21	14-33	
	17-19			
	20-21			

The variable system concept could be made more inclusive by allowing for spatial as well as temporal passage. If each of several elements are measured in several ways, large groups of variables could be connected with lines indicating correlation only; however only a small fraction of these would necessarily be connected by arrows representing a temporal or spatial sequence. Since most morphometric data are accumulated by measuring several variables at an instant in geologic time, it would seem that this is primarily a spatial problem, though it does not rule out the possibility of inductively building a temporal sequence. It is perhaps easier to visualize a sequence of events occurring purely in time rather than purely in space because of the difficulty of visualizing a spatial passage that does not involve temporal passage; however with the passage of time even that is difficult to visualize. Variables connected by arrows will indicate a sequence that occurs in time-space. Melton's use of the variable system concept assumes, in the extreme, that, (1) the elements chosen were sampled at instants representing the entire process and (2) enough space is available for all these elements of the process to operate. In regards to the first assumption, if unique landforms develop in unique climates, then the smaller the area sampled, the narrower will be the range of measured responses of the elements to the environment. If the landscape is in the perfect uniform-steady state, then all variables should appear independent of each other. It is implicit in the first assumption that the rate of adjustment of various components in the system with respect to time is different. This implicit statement leads directly to the second assumption in that the rate of adjustment may be sensitive to spatial requirement.

Melton (1958, p. 445) defines the environment of the variable system as the set of variables governing, or correlated with, at least one variable in the system. The difference between the variable system and its environment is that each variable in the system is rather highly intercorrelated with each other, whereas the variables in the environment govern at least one variable in the system to which it may or may not be correlated. Examination of the cluster diagram or the diagram of correlations sets will usually indicate whether a variable belongs to the system or to its environment. In some cases a variable may be placed either in the system or its environment; consideration of the geomorphic system and of the interpretation being placed on the variables will usually indicate to which it should be assigned. A variable in the environment is causally independent of changes in the system even though it can affect a change in the system. Similarly an independent variable may be included in the system but only one such variable may be included in the variable system because if more than one variable was included they would not be independent. One or more variable systems can be included in one geomorphic system.

If a variable in the variable system changes from a dependent variable to a linearly independent variable in response to temporal or spatial considerations, this newly independent variable may either remain in the system or be assigned to the environment if it governs some variable in the variable system, or it will have to be dropped from the variable system. If, at the level of space and time now being considered, this newly independent variable governs other variables, then a new variable system must be hypothesized; in fact the make-up of all the variable systems under consideration may change or may undergo a gradual change in response to temporal and spatial considerations. A change in an independent variable, e.g. climate, lithology, etc., may also cause the newly independent variable to revert back to a dependent status.

Before proceeding further, it might be well to state explicitly what is meant by steady, unsteady, uniform, and nonuniform states. Whether a variable is steady or not depends on the type of movement with respect to time that is operating: a trend, cyclical, or random movement. Theoretically one, two, or all three of those movements may be acting. This does not mean that if they are present they have necessarily been recognized. The trend of an independent variable might well be steady and the cyclical or random movements superimposed on the trend may, or may not, be of sufficient magnitude to affect changes in the variables that it governs. If the cyclical movement is large enough to cause changes in the system, the system may appear to be unsteady, whereas for a much larger interval of time the system would appear to be steady. On the other hand, if the cyclical movement is not large enough to affect changes in the system, the system will be steady even though the independent variable is unsteady. A similar argument may be developed for the random movements depending on whether or not they exceed some threshold value.

The uniformity of the landscape, or the lack of it, may be more difficult to visualize than the previous temporal arguments, probably because of a preoccupation of humans with time. Space may be used both as a dimension of, and a factor in, the system and the environment; nonetheless a parallel set of arguments for uniformity compared to those of steadiness may be constructed because of the similarity of temporal and spatial passage. The difficulty comes in the interpretation of a gradient that is recognized from observation made at one instant in time. For this gradient to be purely a spatial gradient, several restrictions would have to be placed on the system and its environment, one of which could be that all the elements should have originated at the same time. For this gradient to be purely a temporal gradient several restrictions would have to be placed on the system and its environment, one of which could be that all the elements originated at different times. Several more restrictions can be visualized, but the uncertainty of all the desired restrictions operating simultaneously through the interval of time or space is great; therefore it is extremely difficult to visualize a spatial gradient divorced of time or a temporal gradient divorced of space in landforms. To summarize the preceding arguments:

1. If a variable is in the steady state for the time unit selected, it is not only constant in time but also ideally uncorrelated to all other variables.
2. If a variable is uniform for the landscape unit selected, it is not only constant in space but also ideally uncorrelated to all other variables.
3. If a variable is unsteady, other members of the system may or may not be steady.
4. If a variable is nonuniform, other members of the system may or may not be uniform.

5. If a variable is uniform-steady for the landscape and time unit selected, it is not only constant in space and time but also ideally uncorrelated to all other variables.
6. If a variable shows a range of values, the system may be in any one of the four conditions of state.

How well the variable system is expressed depends on the number and relevency of the variables selected and on the temporal and spatial order in which one presents the coherent factors of the landscape. These factors should be presented so as to simulate as closely as possible the manner in which phenomena occur in the field, as well as to present an interpretive imagery of the processes, by which the spatial arrangement of the phenomena has come into existence.

INTERPRETATION BY VARIABLE SYSTEM THEORY

General Statement

There are three general kinds of variable systems, those that use positive, negative, or no feedback in their operation. These kinds of variable systems may be combined into larger composite variable systems.

The first portion of this section will demonstrate positive and negative feedback prior to combining these examples into a composite system. These examples are adapted from the literature.

The second portion of this section will demonstrate how the preceding composite system may be expanded by induction utilizing published information of several authors. The data and results of these various studies represent in part numerical and in part qualitative arguments yet they may be combined within the framework of one variable system. This variable system constitutes a hypothetical statement about the correlation structure of the variables included in the system. It should be possible, by reasoning in the opposite direction to developing the variable system from the correlation matrix, to determine the cluster diagram or correlation diagram and ultimately a correlation matrix composed of relative values of the correlation coefficients between variables.

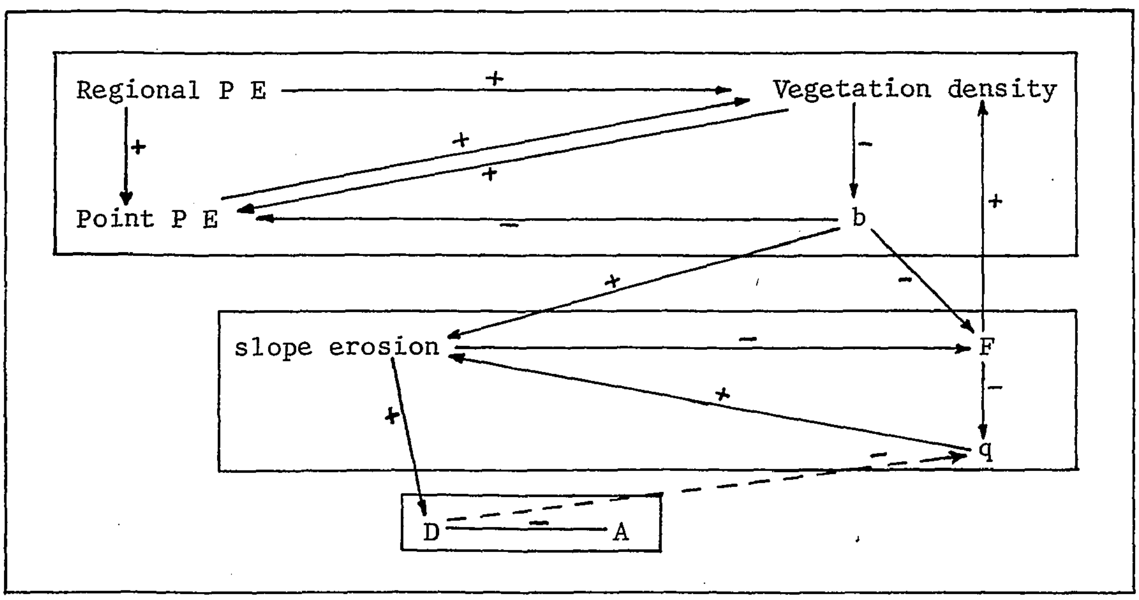
The third portion of this section has been developed using the morphometric data especially collected for this study. Melton's (1958) variable systems were substantiated, and new systems are proposed. The new systems were constructed in the manner outlined earlier in the section entitled "Method of Interpretation". The new systems are combined with the since the Smoky Hill River Basin is a long, narrow, east-west trending basin.

The negative-feedback variable system is characterized by the presence of at least one variable loop in the direction of causality by which one variable, such as runoff intensity q, governs other variables, such as erosion and drainage density, D, which in turn governs the first variable in such a way that it will return to its prior value:

$$\begin{tikzcd} \text{Rainfall intensity} \arrow[r, "+"] & q \arrow[d, "+"] & D \arrow[l, "-"', "?"] \\ & \text{Erosion} \arrow[ur, "+"'] & \end{tikzcd}$$

This negative-feedback loop was tentatively proposed by Melton (1958, p. 454) and labeled as questionable.

Melton (1958, p. 454) combined the two preceeding variable systems with a third variable system to form a composite variable system containing climatic and surficial controls of scale of topography:



where f = infiltration capacity. This composite variable system may be expanded by combining it with several no-feedback variable systems to show greater interrelationships among the variables.

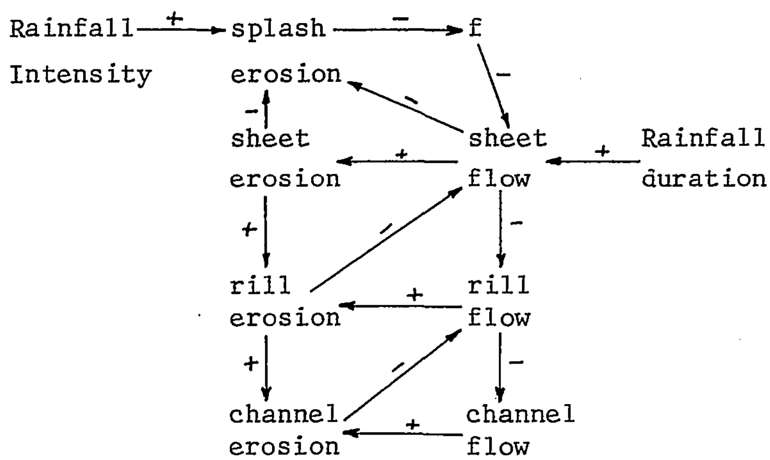
A Variable System Developed from the Literature

The infiltration capacity-runoff variable system uses slope erosion as one variable in the feedback loop. This positive feedback variable system will be expanded before developing more variable systems to this new composite system.

The erosive actions of water are the effects of the energy of falling rain and flowing water over the land surface. Runoff refers to the water which flows on the surface in the form of shallow layers of water spread more or less uniformly over the land surface or of channel flow concentrated into defined watercourses. Runoff also includes the water returned to the surface as effluent seepage (Veatch, 1906, p. 53). It may be expressed as either a rate or a quantity (Ellison, 1947c, p. 245). Runoff is a spasmodic continuum in space-time from sheet flow through rill flow to channel flow. At a given instant in time during a rainstorm the three types of flow may be visualized as a triangular continuum through the space of one drainage basin where runoff may go from sheet flow through rill flow to channel flow, or from sheet flow to channel flow. The type of flow at any given point in the drainage basin may oscillate through the interval of the storm. In general only sheet flow will occur on the intervalley divides, whereas the entire continuum may be operating in the valley bottoms.

The same approach may be applied to soil erosion with one addition, splash erodion. In this case a tetragonal continuum exists: splash erosion through sheet erosion through rill erosion to channel erosion. In general only splash erosion and sheet erosion will occur on the intervalley divides, and at the highest elevation on the divide only splash erosion occurs; whereas the entire continuum may operate in the valley bottom. Since the occurrence of valleys can be observed and if it is assumed that these valleys are the result of the soil erosion process acting on a previous surface of less relief, then it must be concluded that the amount of material removed per unit area, the soil loss, must have increased from the divide to the valley bottom during at least part of its history. In order to understand how the present profile reached its position in space-time and to predict new positions in space-time, the rate of soil loss in the space of the drainage basin through time must be estimated.

It would seem that what Melton (1958, p. 454) refers to as slope erosion includes splash erosion, sheet erosion, and rill erosion; likewise Melton's use of runoff, q, includes sheet flow and rill flow. It is now possible to expand his infiltration-runoff variable system to include these variables as well as channel flow and channel erosion:



This composite variable system will now be discussed. The purpose of the discussion is to imply a likelihood that the slope profile depends on the type and the location of the slope erosion, which in turn depends on the properties of the material being eroded and on the intensity and duration of the rainfall that characterizes the region.

Ellison (1947c, p. 443) has shown that the transportation factor in soil erosion tends to decrease the soil loss with an increase of slope length, whereas gulley erosion tends to do the opposite. A drainage basin in equilibrium may represent a balance of these opposing tendencies for a given climate. Vegetation will play an important part in the morphology of a basin; it is also a function of climate.

Splash erosion results from detachment of soil particles by raindrop impact and from transportation when a directional unbalance occurs as on sloping land, with high winds from a preferred direction, etc. The beginning of sheet flow marks the transition from splash erosion to sheet erosion. There will be a zone paralleling the crest line of the intervalley divide where splash erosion will be the dominant type of erosion occurring. This process will tend to level the surface, and, in regions where splash, sheet, rill, and channel erosion occur, it will control the rate at which the divide will downwaste, which in turn is controlled by the rainfall erosion potential and the inherent properties of the soil. Splash erosion may or may not grade into sheet erosion with increasing distance from the crest line. An example of the latter is a pile of sand on which sheet flow seldom, if ever, occurs.

The term sheet erosion was first used and defined by Chamberlin and

Salisbury in 1906 (A.G.I. Glossary, 1960, p. 263) as: "In the first case the water flowing off over the surface (the run-off) will descend equally in all directions. It will constitute a continuous sheet of surface-water, and both its volume and its velocity will be the same at all points equally distant from the summit. Erosion accomplished by sheets of running water as distinct from streams is sheet erosion." Sheet erosion has been defined by Baur (1952) as "removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and runoff." Sheet erosion is a function of rainfall characteristics although the magnitude of the effects varies with the inherent properties of the soil, the length and per cent of slope, cover, and management practices. Much of the raindrop energy may be expended in puddling the soil and sealing of the land surface and in direct compaction of the soil. The detached colloids will flow down the slope and infiltrate into the soil. This often results in increased runoff.

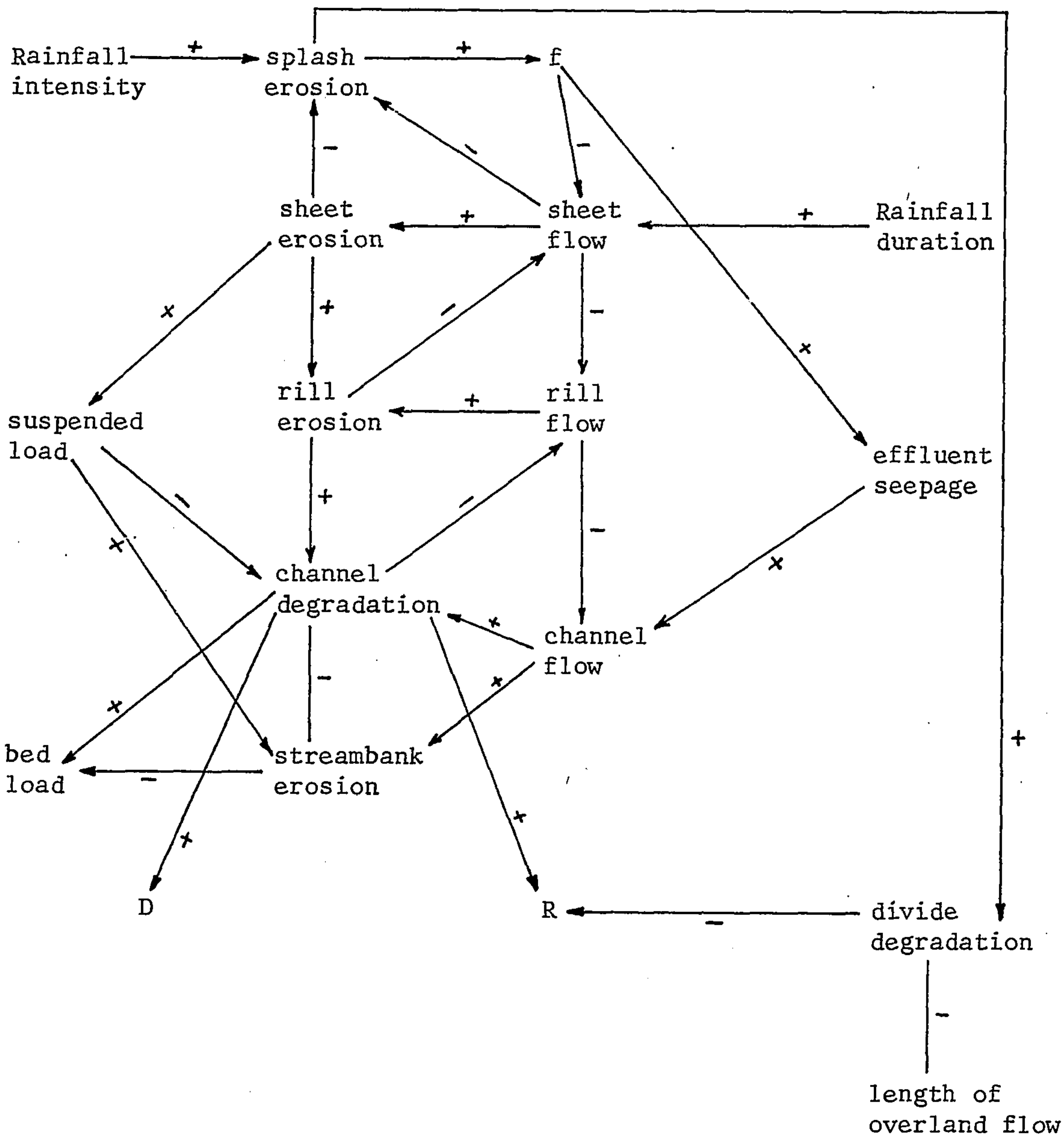
Ellison (1947a, p. 145), working with sheet and rill flow, observed that when only clear water was applied to a clay bed, there was maximum transporting capacity and minimum detaching capacity, and very little erosion. When the applied water was fully charged with soil, there was maximum detaching capacity and minimum transporting capacity, and again very little erosion. He concluded that maximum erosion will occur when the detaching and transporting capacities of flow are balanced, that is, when the flow contains just enough abrasive materials to detach as much soil as the flow will carry. This condition of balance will change with each change in the soil's erodibility. A condition of flow which is most erosive on one soil, therefore, may not be most erosive on another soil. From Hjulstrom's (1939, p. 10) curves for soil loss (Hjulstrom calls it erosion), transportation, and deposition of uniform material it is possible to infer that sand has high detachability and clay low detachability, whereas sand has moderate transportability and clay a high transportability. Sand and clay are, therefore, of low erodibility, but for different reasons. This has been confirmed by Ellison (1947a, p. 145), but he did not make clear his basis for this confirmation.

When rainfall intensity exceeds the infiltration capacity and all the minor surface depressions have been filled and surface detention has accumulated, excess water moves downhill, providing transportation for many of the detached soil particles that would not otherwise move off the plot. The velocity attained by the flowing water is a function of its depth, the surface roughness, and length and degree of slope. Wischmeier and Smith (1958, p. 289) state that the silt carrying capacity of flowing water increases exponentially with increasing velocity. Not only soil detached by raindrops, but also additional soil detached by the flowing water, is transported down the slope. Wischmeier and Smith (1958, p. 289) feel that this material "is carried down the slope in increasing amounts as the depth of flow increases." Too much is implicit in this last statement for it to be explicitly clear. If we assume that the depth of sheet flow increases, without saying how it increases, as the distance from the crest increases, then the erosive action of the splash process would be expected to decrease in this direction because more and more of the energy of falling raindrops is being imparted to the surface flow. This does not necessarily mean that the energy imparted to sheet flow by raindrop impact will increase the erosivity of the sheet flow, as it may already have maximum trubulence as a result of the roughness of the surface and the velocity of flow. If the detachability of the soil is high for the splash process, then the surface flow would, at least initially, be fully charged, and thus would have maximum detaching capacity and minimum transporting capacity, resulting in very little erosion. As the depth of flow increases downslope, the velocity of flow should also increase and the detaching capacity will decrease and the transporting capacity will increase, resulting in erosion by scour increasing until the detaching and transporting capacities are in balance, at which time maximum scour will occur. At some time in the sequence described in the immediately preceding sentence, rilling may begin due to differential erosion of an inhomogeneous material. If the detachability of the soil is low for the splash process, then the surface flow conceivably might not, initially, be fully charged resulting in a minimum detaching capacity and a maximum transporting capacity and again very little erosion. If the depth of flow increased downslope, the velocity might also increase. The velocity would have to attain a relatively high value for sheet erosion to begin which might result in rilling beginning at a greater distance from the crest of the divide.

The term "rill" has long been used to mean a very small trickling stream of water. Rill flow may form transition between sheet flow and channel flow and as such defies rigorous definition. Fenneman in 1909 (AGI Glossary, 1960, p. 247) had this to say about rills: "Traced headward, however, the stream is found to consist of many smaller ones. A degree of subdivision will ultimately be found in which the individual streamlets are so impeded by friction that the available power is not sufficient to transport the load found along its course. The word rill is suitably used to denote streamlets of this kind." Baur (1952) refers to the size of rills in his definition of rill erosion: "removal of soil by running water with the formation of shallow channels that can be smoothed out completely by cultivation." This size would certainly seem to be of the same order of magnitude as the rills to which Horton (1945) repeatedly refers. Looking at rills from the point of view of process of a given time, certainly they must be formed by local intensification of scouring action and at the same time the splash process is attempting to level the inter-rill divides. Rills must, therefore, represent a balance between the splash process and incipient localized scour. A rill is the morphological expression of this balance between opposing processes: splash is attempting to decrease the extremely localized relief and scour is attempting to increase it. This balance for a particular rainstorm or distribution of rainstorms, as modified by the inherent properties of the soil and length and per cent of slope, may be obliterated by channel erosion, but it is never upset. With time the rills will migrate up or down the slope depending on whether the degree os slope is increasing or decreasing, all other factors remaining constant. Gottschalk (1957, p. 337) visualized channel erosion to comprise mainly gully erosion, streambank erosion, and channel degradation as a result of forces exerted by concentrated flow. He also stated that channel erosion is the primary source of the bed load; whereas the "wash-load" of sheet erosion was the source of the suspended load. Once the factors that control the rate of valley degradation are known, the factors that control the relief of a drainage basin will be known, since splash erosion controls the downwasting of intervalley divides.

In summary, raindrops and surface flow are separate erosive agents which may operate singly, as a gradation continuum, or as an interrupted continuum. The velocity of raindrops may exceed 30 fps downward; the velocity of sheet flow is generally less than 0.25 fps parallel to the slope; the velocity of streams rarely exceeds 30 fps in the horizontal direction. These widely differing velocity vectors suggest that they will produce widely differing results on the soil. Ekern (1950, p. 23) reports that approximately eight tons per acre of fine sand would be transported by the impact of drops from a rainfall of 4.0 iph continuing for a five-minute period. This force was shown to distribute the material over distances up to five feet. Sheet flow would be expected to be very effective in transportation and very ineffective in detachment. The opposite would be true for rain. Sheet erosion tends to be imperceptible in depth but widespread in area. Conversely, channel erosion is readily apparent in depth but limited in area. Glymph (1957, p. 903) believes that sheet erosion is clearly the dominant source of sediment in most of the 113 watersheds that he studied and that this is generally the case in the more humid part of the country. Glymph (1957, p. 905) classified the percent relative sediment sources as sheet, gully, stream channel, valley trenching, and other. By valley trenching he means "generally the entrenchment of ephemeral channels by headward advancement in alluvial plains as distinguished from upland gully erosion." Valley trenching is probably responsible for the greater proportion of first order streams flowing directly into higher order streams in the lower half of higher order streams. Some of these streams may be initiated by piping.

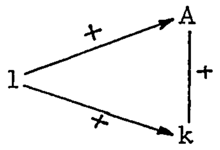
The preceding discussion may tentatively be summarized in a much enlarged infiltration-runoff variable system in which the effects of creep are ignored:



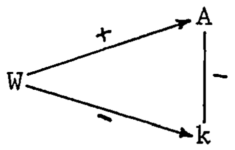
Several additional variable systems will now be developed composed of commonly measured morphometric parameters. These variable systems will then be related to the infiltration-runoff variable system to demonstrate its effect on the commonly measured morphometric parameters.

Variable Systems Developed from Correlation Matrices

A no-feedback variable system contains two or more variables, one of which may govern the others, or there may be no unique direction of causality between any pair of variables. The effect of basin length, l, and basin width, W, on the area and shape of the basin, k, illustrates this system.

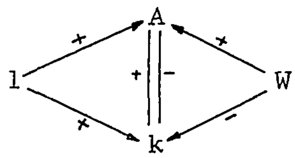


If a basin is free to extend itself parallel to the basin azimuth, this extension will increase both A and k, and A and k will be positively correlated by not in a causal sense, thus no arrow between A and k.



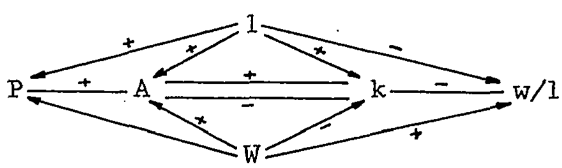
If a basin is free to extend itself laterally outward from the basin azimuth, this extension will increase A and decrease k, and A and k will be negatively correlated.

If a basin is free to expand outward in all directions, these two no-feedback systems may be combined and the net effect may be that no change in k will occur.

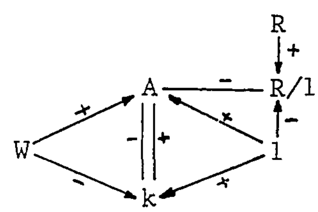


The apparent effect is the same as would be expected if a negative-feedback system was operating. Examination of the correlation between A and k will indicate whether the drainage basin is extending itself parallel to the basin azimuth or laterally outward from it. In the study area a positive correlation exists between A and k for all basins regardless of order, and for all basins grouped by order, and for all basins of a given order grouped by the order of the stream that they intersect except that basins 1-5 and 3-4 show a negative correlation. The reason the 1-5 basins have a tendency to enlarge themselves laterally outward from the basin azimuth has been discussed elsewhere and the same reasoning applies to the 3-4 basins.

Variables equivalent to w/l have been used to characterize the shape of drainage basins. This variable and the basin perimeter, P, may also be included in the above variable system.



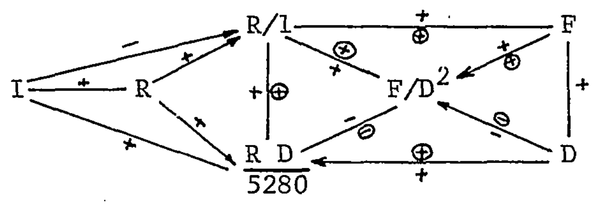
A basin may also change in the vertical dimension. The relief will increase if the valley floor is downwasting at a greater rate than the divides are downwasting. The relief will decrease if the divides are downwasting at a greater rate than the valley floor is downwasting or if the stream is alluviating. Relief and slope may now be added to the previous no-feedback system:



As the relief, R, or 1 increase the slope, S, will increase or decrease, respectively. If 1 is increasing, A and S should be negatively correlated; however if R is increasing very rapidly such that S is increasing, even though 1 is also increasing, the A and S would be positively correlated. Examination of the correlation coefficients indicates that in general the lower order streams are more negative than the higher order streams (Table 3). If it is again assumed that this no-feedback system is operating in the study area, the higher order streams are coming increasingly under the influence of R and decreasingly under the influence of 1 and W.

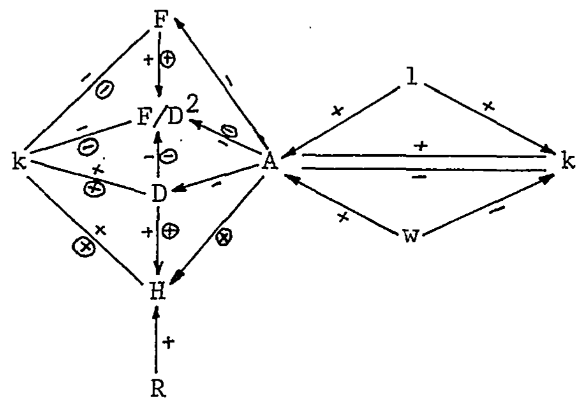
The regression equations in the 1-W variable system will indicate the general magnitude of the above relationships. A residual map of these relationships will indicate how these effects are areally distributed.

The variables dealing with relief can be isolated into a separate variable system, the relief-texture variable system:



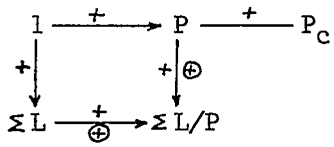
The slope, R/l, and the ruggedness number, RD/5280 = H, have a correlation greater than or equal to zero. A positive correlation between these two variables would be expected since R is in feet and l is in miles. The interesting facet of this correlation is that it may approach zero. From the way the variable system is constructed, the only other variable that could cause this situation is basin length, l. It is thus possible that in the rilling stage the correlation will tend to be negative; in the gullying stage, positive; in the equilibrium stage, negative.

The ruggedness number, H, and the relative density, F/D^2, have a correlation less than or equal to zero (Table 3). A negative correlation between these two variables means that the more rugged an area is: (1) the longer will be the streams if the number of channel segments and the area are kept constant; (2) the smaller will be the area if the number of channel segments and their length are kept constant; or (3) the number of channel segments will be less if the length and the area are kept constant. A zero correlation indicates that in some situations H and F/D^2 have no linear relationship to each other, and it appears to be restricted to the basins with the higher order lag of the higher order basins. The change from negative to zero correlations suggests that there might be either an limit of size and shape beyond which the variables are not related or an range of size and shape within which there is a transition from negative to positive correlation:

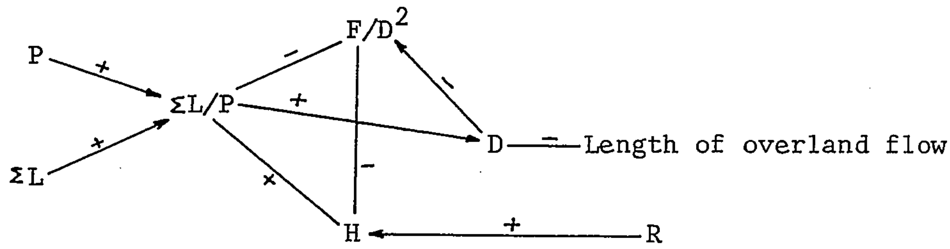


Basin shape, k, has little effect on F or D except for small basins, probably less than one square mile, even though the area is significantly correlated to F and D over a greater range; essentially the opposite trend occurs for k and A on D_R and H. For a small drainage basin D will probably remain constant; this change will cause F/D^2 to decrease and H to increase. If, for a small drainage basin, k decreases in response to an increase in W, then D probably would increase (this is not reflected in the data) and F would remain constant until the length of overland flow exceeded the critical distance then F might increase causing F/D^2 to continue to decrease and H to continue to increase. If k remains constant in response to an increase in both l and W, the drainage basin will at some point exceed some critical size and be independent of k; thereafter F and D will decrease as the larger channel segments incorporate smaller channel segments into them until H and F/D^2 show no significant correlation which hopefully occurs in the equilibrium stage.

Basin length, l, and calculated perimeter, P_c, form a basic pair in all clusters at all levels and in all correlation sets. A small nofeed-back system can be constructed illustrating the relationship of 1, L, P_c, and measured perimeter, P:



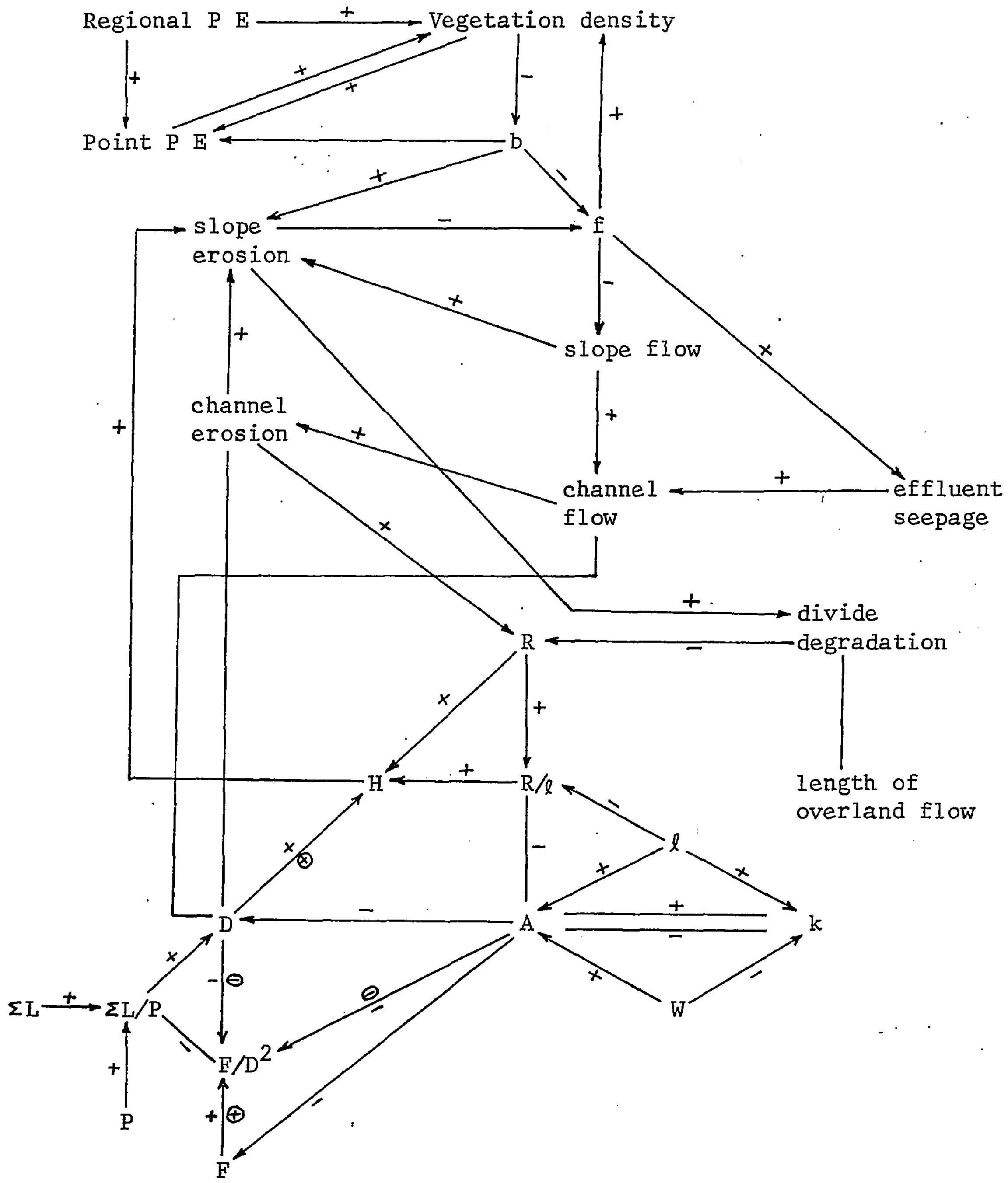
For the lower order basins L is increasing much faster than P; thereafter L and P are increasing at the same rate over the sample. There appears to be a tendency for this relationship to reverse for orders greater than four such that P is increasing much more rapidly than that P is increasing much more rapidly than L. The effect of these changes on the drainage system may be illustrated with a variable system:



If a very narrow interval of space-time is considered, relief will not be a controlling factor; whereas for a very broad interval of space-time, relief will probably be a controlling factor. When L is increasing much more rapidly than P through a narrow interval of space-time, such as during the inequilibrium stage, the drainage density, D, is also increasing;

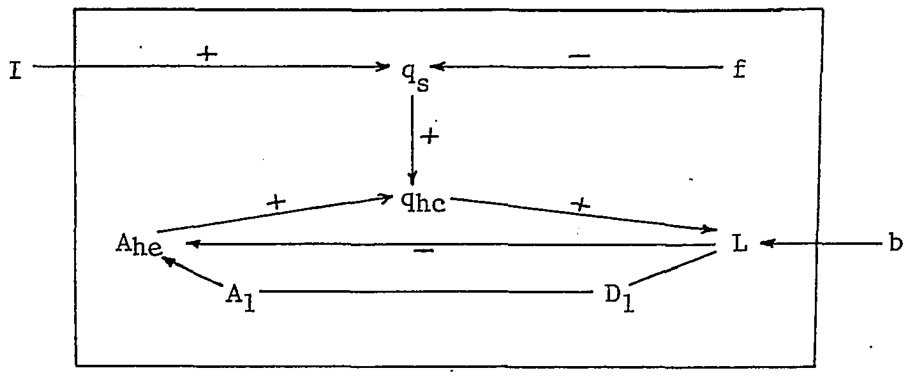
changes in relief over this narrow interval will be insignificant compared to the changes in total stream length. If L and P are increasing at the same rate over a narrow interval of space-time, then all the variables in the system will appear constant and will show no significant correlation to each other. It is difficult to visualize a situation for which P would be increasing much more rapidly than L for a narrow interval of space-time; however for a broad interval of space-time, especially in the equilibrium stage, this relationship seems reasonable. As the interval of space-time broadens, relief becomes increasingly important. A large change in R will cause a large change in H whether it occurs solely through time, solely through space, or through space-time. Changes through exceeding small intervals of space-time will be reflected by changes in the hydraulic geometry; however as the interval broadens these changes will be impressed upon the landscape.

All the preceding variable systems may now be placed in one composite variable system. Some of the individual variable systems will be simplified to reduce the complexity the composite picture:


Regional P E
Vegetation density
Point P E
b
slope erosion
f
slope flow
channel erosion
channel flow
effluent seepage
divide degradation
R
length of overland flow
H
R/ℓ
ℓ
D
A
k
ΣL
ΣL/P
F/D²
W
P
F

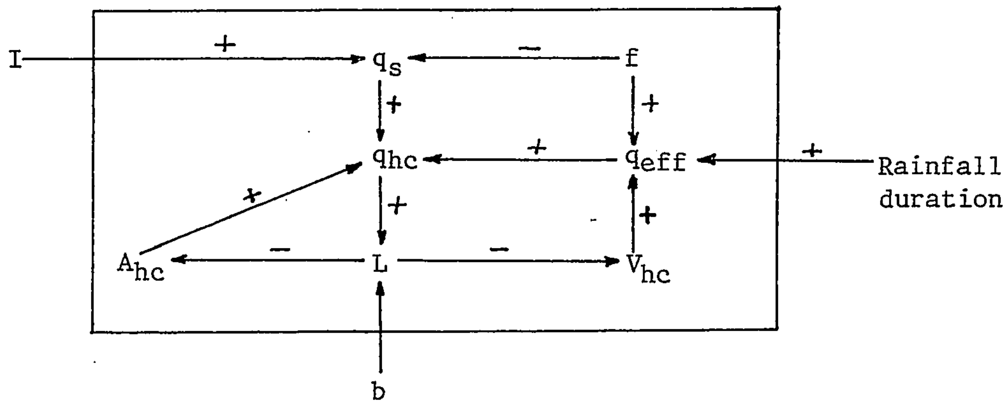
The preceding variable system, in general, applies to all drainage systems, although certain progressive changes were recognized associated with increasing order lag. These can not be wholly explained by a change in area. It may be that some of these changes can be explained by considering a drainage system of increasing complexity. Such a study would for practical reasons entail a progressive change in map scale and a detailed field and laboratory investigation. By way of illustration a comparison can be made between the variable system regulating channel length in first order basins and the variable systems regulating channel length in large drainage systems.

Melton (1958, p. 455) has developed a variable system illustrating the mechanism of control of channel length, L, by runoff intensity, q_s, and proportion of bare area, b, in a first order basin. This first order basin is one mapped on a scale of 1/24,000,



where q_{hc} = channel discharge at its head and A_{hc} = area drained by the channel head. This negative-feedback system is important only for small areas and contrasts strongly with the composite picture developed previously. The mechanism by which streams bifurcate is not thoroughly understood; the system must, therefore be very general. The striking fact remains that many more variables are involved in explaining the stream length of a large drainage system than of a first order basin.

The preceding variable system illustrating the mechanism of control of channel length in first order basins has ignored the effect of effluent seepage at the channel head, q_{eff}:



where V_{hc} = volume of aquifer feeding the channel head. This variable system indicates that in arid regions the channel extension will be controlled primarily by surface runoff; whereas in semiarid regions streams that truncate an extensive aquifer will have their length regulated effluent seepage. In the more humid areas this variable system will have to be expanded to include the role of creep.

Conclusions

More data and greater understanding of fluvial erosional processes will be required for further analysis of drainage basins by variable system theory. It was shown that it is not always necessary to restrict the variables in the correlation matrix to those that are independent of each other to obtain meaningful results; however it became very apparent in some cases that by not so restricting the variables that basic pairs could occur in which the two variables measured essentially the same thing. The complexity of the variable system increases as the number of variables increases and as understanding decreases.

Melton (1958, p. 459) states that the variable system provides a mathematical model for the correlation structure of the available variables. The mathematical model developed for one area may be compared or contrasted with that for another area. It may be possible to develop different models for different morphogenetic regions so that predictions may be made of regions where information on certain variables is lacking. It may be possible to predict the effect of man-induced changes on the face of the earth and thus help man comprehend his role in the ecosystem.

TREND SURFACE ANALYSIS

General Statement

Abrupt changes of a large magnitude in the landscape are easily recognized in the field, from maps, or from airphotographs. Progressive changes or abrupt minor changes are more difficult to recognize. Often such changes are masked by a great mass of detail. The problem is to recognize the regional trend, and perhaps any systematic or random movements superimposed on the trend. Trend analysis involves separating these components from each map observation.

This study assumes that each variable is a linear function of the longitude variable. The estimated regression line represents the trend. Observations which deviate from this regression line are called residuals. Both the trend and the residuals may be mapped.

Trend analysis is usually less difficult when the data is on a rectangular grid. Most geologic data cannot, however, be collected on grids and such is the case in this study. All map data in this study have been plotted at the center of the drainage basin from which it was collected. Since most of the variables are areal measurements this method of locating the mapped data is somewhat arbitrary, except possibly with the dimensionless variables. All this means that there are certain theoretical, philosophical, and practical reservations concerning trend analysis and interpretation. These reservations are discussed elsewhere in this paper under system analysis.

Trend surface analysis has been used in geology mainly to test a model or to make predictions. It may also be used to detect subtle progressive changes or abrupt changes of a small magnitude which are masked by local effects; in this case the question of how good some variable is in predicting another variable is nearly meaningless because the trend will only account for a very small proportion of the total map variability. The correlation coefficient in such studies will be very low, whereas if regression techniques are used for prediction purposes the correlation coefficient should be high.

The mathematical model assumed for the analysis of variance for simple linear regression is

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i \; ; \quad i = 1, \ldots\ldots n$$

where Y_i is an individual observation; β_0 is the Y intercept; β_1 is the slope of the regression line; X_i is the independent variable; n_i is the total number of values of X (or Y) and ϵ_i = NID $(0, \sigma^2)$.

Drainage Density

The drainage density, D, was regressed on the longitude variable for all second order streams. The equation of the regression surface is: D = 6.98 - 0.059 Long. (Figure 15). The ratio of the regression sum of squares to the corrected sum of squares is the estimated proportion of the total map variability accounted for by the linear surface; in this case the linear surface accounts for 3.6% of the total map variability. This low value raises the question of just how good the trend is.

One way to evaluate the strength of the trend is to test the null hypothesis that the slope of the surface is equal to zero. The standard F test of this hypothesis indicates significance at the one percent level, which means that the probability of obtaining a value larger than the calculated F value, if no trend existed, is less than one percent (Table 5). The null hypothesis is thus, not accepted, and it is inferred that the linear relationship is real.

Since the linear surface accounts for only 3.6% of the total map variability, then 96.4% of the total map variability is accounted for by the residual. If the trend is real, it has been obscured by secondary effects. The residual map shows that the largest percentage of the mapped area is mapped as negative residuals, thus the positive residual areas will be more strongly positive than the negative areas will be negative (Figure 15). The positive residual areas are, with only two exception, associated with stratigraphic breaching. The two exceptions are enclosed either entirely in the Niobrara chalk bed or the Ogallala Formation. The residuals are higher in the former unit. It can thus be concluded that the drainage density will increase in response to stratigraphic breaching from clastic to carbonate rocks. It also appears that the drainage density on carbonate rocks alone may be higher than on clastic rocks alone, but that the highest drainage density will be attained at some time where breaching is occurring.

It appears that the effect of lithology is masking a subtle increase in the drainage density from west to east. This subtle increase in the drainage density may be associated with the precipitation increase, and its related effects, in this direction or with an earlier development of the eastern part of the basin. If the latter is the case, the relative density might be expected to increase from west to east; the correlation

Figure 15. Residual map (upper map) and trend map (lower map) of drainage density on longitude variable.

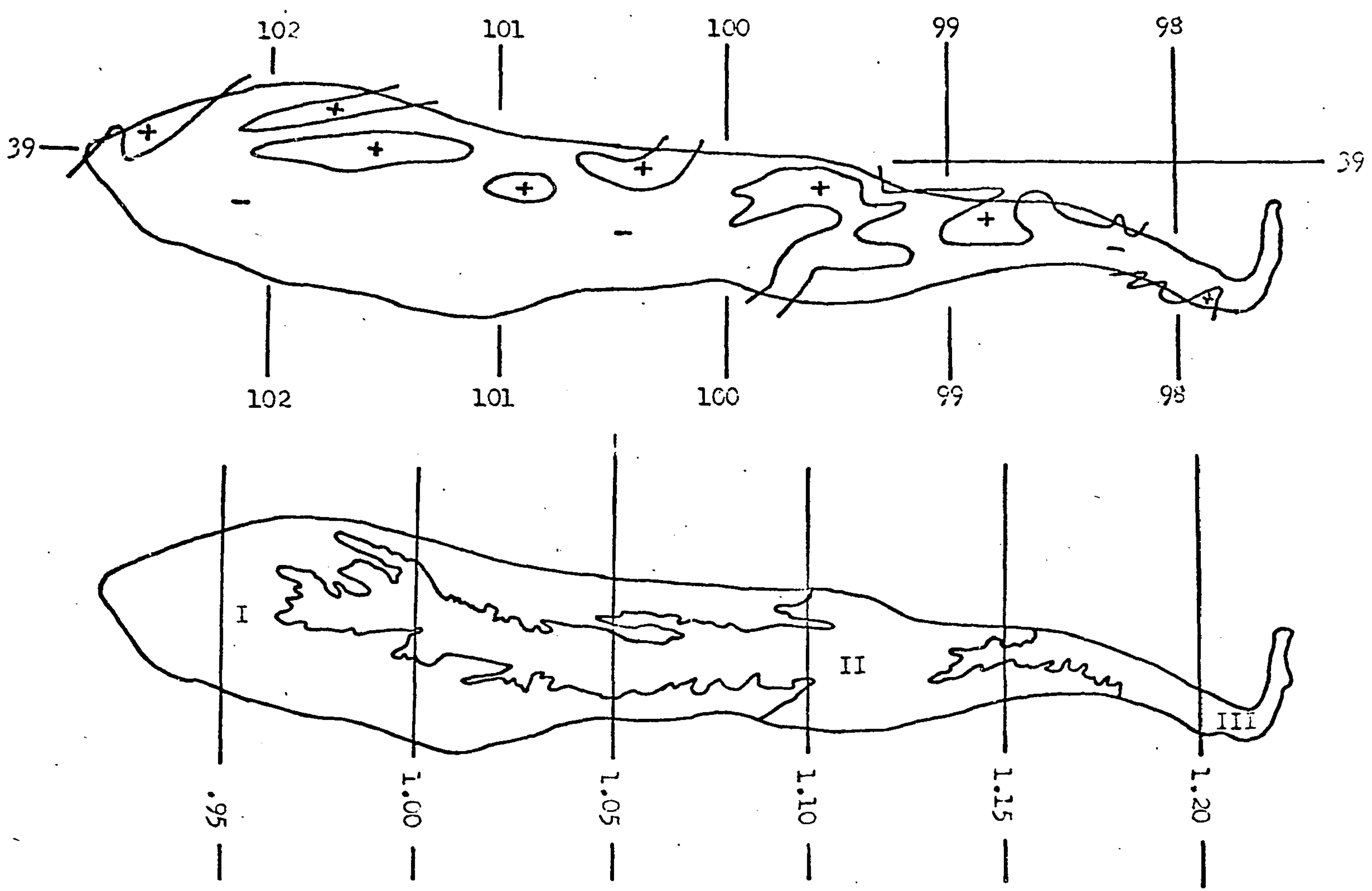

102
101
100
99
98
39
39
102
101
100
99
98
I
II
III
.95
1.00
1.05
1.10
1.15
1.20

Table 5. Analysis of variance

Source	DF	SS	MS	F
	Drainage density on longitude			
Regression	1	1.733412	1.73321	9.40055**
Residual	251	46.277855	.184373	
Total	252	48.011068		
	Relative density on longitude			
Regression	1	.4873183	.4873183	14.030408**
Residual	251	8.7179860	.0347330	
Total	252	9.2053043		

**Highly significant

coefficient between relative density and longitude indicates that this is the case.

Relative Density

The relative density, D_R, was regressed on the longitude variable for all second order streams. The equation of the regression surface is: $D_R = 3.5501 - 0.0315$ long. The linear surface in this case accounts for 5.3% of the total map variability. The slope of the regression surface differs significantly from zero at the one percent level, and it is inferred that this linear relationship is real.

This trend has also been obscured by secondary effects. The residual map shows that the largest percentage of the mapped area is mapped as negative residuals, as in the case of drainage density on longitude. The positive residual areas are associated with stratigraphic breaching, except in two instances. These two exceptions are enclosed either entirely in the Niobrara chalk beds or the Ogallala Formation, and the residuals are of the same magnitude in both units. The orientation of the positive residual areas are both parallel with and normal to the trend (Figure 16).

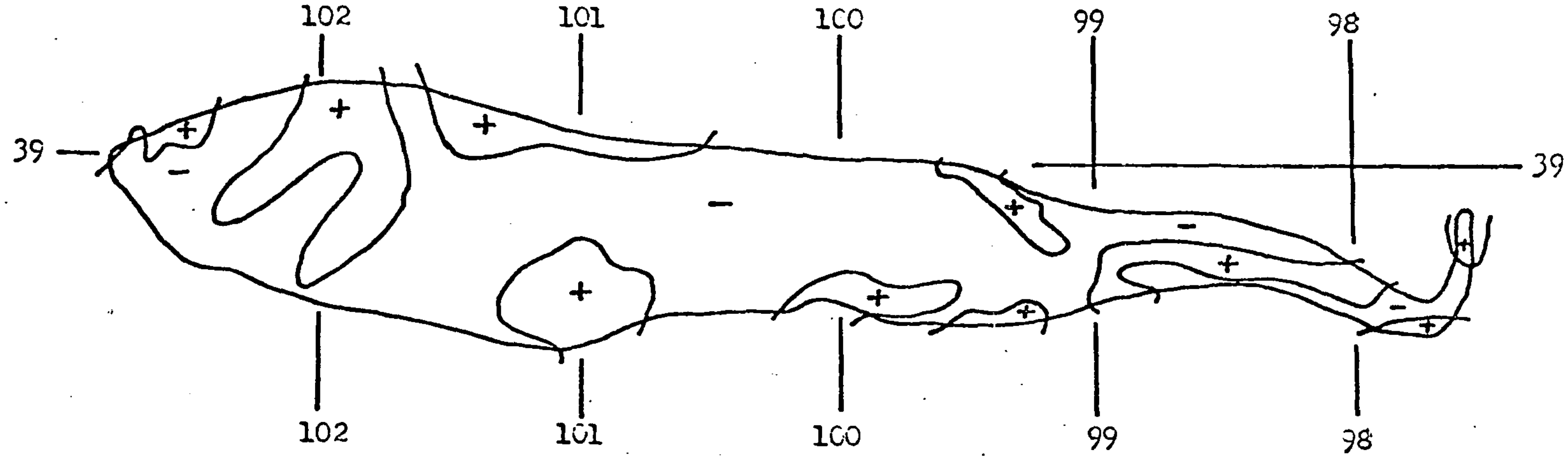
It again appears that the affect of lithology is making a subtle increase in the relative density from west to east. This subtle increase is probably associated with an earlier development of the eastern part of the Smoky Hill River drainage basin resulting in a more completely filled basin outline by the channel net.

Conclusion

The previous two examples of simple linear trend surface analysis have illustrated its possible use to detect subtle progressive changes or subtle abrupt changes in the landscape that account for only a small percentage of the total map variability. It was also illustrated how this technique could be used to possibly isolate a cause of the trend.

Table 6 shows the significant percentage of the total map variability accounted for by the various variables when these variables are regressed on the longitude variable. It is apparent that no single variable could be used to adequately predict the longitude variable or vice versa. It is desirable to find a set of variables that can be used in prediction. Considering only the second order streams for example, variables four through eight and eleven and twelve might be expected to be combined into a single

Figure 16. Residual map (upper map) and trend map (lower map) of relative density


102
101
100
99
98
39
+
−
39
102
101
100
99
98

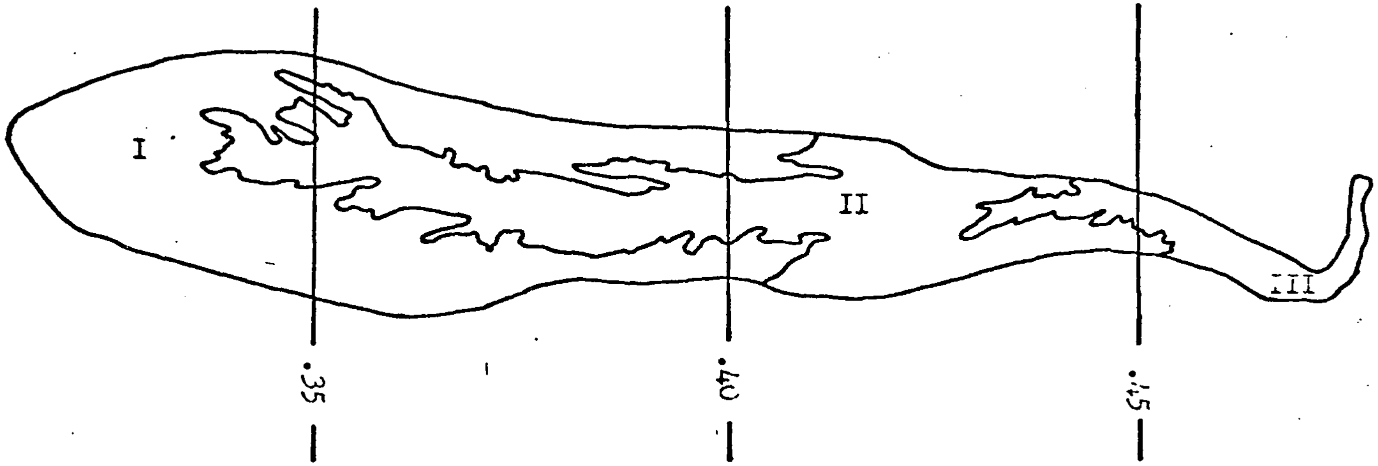

I
II
III
.35
.40
.45

Table 6. Significant percentage of the total map variability accounted for by various variables when regressed on the longitude variable (NS means not significant)

Variables	All streams	First order streams	Second order streams	Third order streams	Fourth order streams
3 on 6	1.90	2.56	NS	10.30	NS
4	NS	NS	6.15	13.60	NS
7	NS	4.77	9.68	15.70	NS
8	.87	6.38	7.86	15.70	NS
9	1.83	10.60	15.20	23.60	NS
10	.57	.50	NS	NS	94.8
11	1.96	10.20	15.00	24.60	NS
12	4.51	7.71	18.20	33.60	NS
13	NS	NS	NS	NS	68.00
14	NS	NS	NS	NS	NS
17	NS	NS	NS	NS	NS
18	NS	NS	NS	NS	78.90
19	NS	NS	NS	NS	NS
20	1.71	1.39	3.61	12.10	NS
21	8.13	7.69	8.27	24.10	NS
22	1.23	1.25	5.58	NS	NS
23	1.51	1.19	6.05	21.00	NS
24	1.53	1.94	NS	NS	NS
25	.36	NS	NS	NS	NS
26	.37	NS	NS	NS	NS
27	NS	NS	NS	NS	62.40
28	.64	5.37	9.92	21.20	NS
31	1.83	9.50	14.30	23.70	NS
32	.61	4.78	NS	NS	NS
33	NS	1.03	NS	NS	NS
34	NS	NS	NS	NS	NS

equation to account for 75% of the variability associated with the longitude variable. Multiple regression techniques, therefore, might profitably be used to explain a higher percentage of the total map variability.

There is no easily applied statistical method for separating trend, cyclical, and random movements. Krumbein and Graybill (1965, p. 337) state that it is sometimes possible on substantive grounds to infer the presence of systematic map effects of order higher than the main trend. No attempt has been made in this paper to develop such secondary trend components, except to group them all on the deviation map. The effect of stratigraphic breaching might have been more accurately portrayed by using higher order models.

SUMMARY AND CONCLUSIONS

Soil erosion studies in the United States have the appearance of being conducted by several completely independent groups. Wischmeier and Smith (1960) have attacked the problem of soil loss largely from a statistical analysis of erosion plot and climatic data. Ellison (1947) and his followers have worked mostly with the factors controlling the erosional properties of soil. Horton (1945) has emphasized the geometry of the drainage net and its origin. Strahler (1957) and his followers have quantified the geometry of the landscape. Leopold and Maddock (1953) and their associates have stressed the hydraulic geometry and some of its physiographic implications. Little (1940) attempted to tie fluvial erosional geomorphology to hydraulics and hydrology. Three main theories have been advanced to explain the landscape; the geographic cycle, dynamic equilibrium, and geographic zonation.

This study began with the very vague idea of relating morphometric variables to something other than themselves. The lack of success of local studies in identifying trends in morphometric studies led me to consider a regional study. The study is exploratory. The results of the trend mapping phase of this study clearly show that significant linear trends do exist. The surprising result of this phase was that the trends accounted for so little of the total map variability, generally less than five percent. It can be concluded that the dependency relations among the measured values are obscured in part by complex interrelations among the variables, in part by a lack of understanding of what phenomena the measured variables are sensitive to, and in part by the omission of significant variables. A variety of search procedures are available to sort the more significant variables, to identify redundancy, and to search for sporadic items which significantly affect the derived statistics (see Krumbein and Graybill, 1965). The fact that the simple linear regression equations account for such a small percentage of the total variability, indicated that multiple regression analysis should be conducted to further establish trends and variations. This phase of the study was concluded at this point because the overall purpose of the study is exploratory.

Analysis by variable system theory is not futile even though the trends account for only a small percentage of the total variability; on the contrary the variable system analysis lends support to a type of analysis which takes into account complex interrelations among variables. It has been clearly shown that variable system theory can only be used to explain rather simple events. All events of a more complex nature are probably beyond the limits of one human's intellect to reconstruct with accuracy and consistency using variable system theory. This type of study, therefore, should probably be continued using the more sophisticated techniques of systems analysis which often allow synthesis of the understanding of the nature and the workings of systems components into a working ensemble.

The results of analysis by variable system theory has shown that it is possible to use this theory in two ways: (1) to combine several diverse studies into the framework of the variable system without recourse to the correlation structure of the variables, and (2) to construct a variable system from the correlation structure of the variables. It was further shown that these two methods may be combined to extend the results. Variable system theory may continue to be used to gain insight into the workings of systems components prior to combining them into a much larger system using computer techniques by the systems analyst.

The study of the landscape by mathematical simulation could be based on different man-made assumptions, for example a time-dependent or a time-independent landscape. The mathematical models built on these assumptions might be quite different. Their validity could be checked by comparing the results for a given set of inputs - the environmental variables - with an actual example. The initial formulation of the problem might be to develop such mathematical models for simulation studies.

The next phase of such a study should involve locating the strategic variables. Any number of search procedures may be used to perform this function, such as cluster analysis followed by factor analysis. This phase should be followed by determining the relation of these variables to the parameters of the system. The latter phase represents an analysis of the chance fluctuations of operations to furnish insight into the statistical dependence of the results on the operational parameters.

The next phase should involve the formulation of a stochastic model. This involves stating the interrelations and interactions among subsystems and their components in mathematical form. Regression techniques could be used during this phase. This model may then be tested by comparing the results for a given set of environmental inputs with an actual example. The results of a series of such experiments should permit the formulation of a series of inequations regarding the conditions for which the model is applicable. A follow-up phase should be specified for correcting the model and the inequations as necessary.

Much of the material of the various approaches to and theories of erosional geomorphology is complimentary. The development of plant ecology, soil morphology, and surface morphology beyond a purely descriptive stage will probably have to be conducted concurrently. An initial synthesis of this tremendous mass of details will undoubtedly be accompanied by simplifying assumptions. It is proposed that the many factors that enter into this complex problem may be combined in a general development, using the methods of operations research. Such a synthesis might be carried on at several levels of geomorphic systems, each of these being a reality which can be observed and measured with varying degrees of accuracy. The concept of these systems in the minds of men may range from qualitative to highly precise and accurate quantitative models. All of the models, regardless of the degree of precision involved, must fit in a philosophical framework which elucidates the implication of current research and within which advances in knowledge and understanding can be made and hidden assumptions searched out.

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APPENDIX A

Correlation Matrices

Table 7. All streams; n = 1375

Var.	1	2	3	4	5	6	7	8	9	10
1	1.0000+									
2	.3179-	1.0000+								
3	.0173+	.0181-	1.000+							
4	.1214+	.0884-	.0604-	1.0000+						
5	.0405-	.0152+	.0059+	.0196-	1.000+					
6	.3258-	.3709+	.1369-	.0491+	.0350+	1.0000+				
7	.0966+	.0525-	.0351-	.8040+	.0034-	.0339+	1.0000+			
8	.1006+	.0666-	.0672-	.9692+	.0154-	.0931+	.9027+	1.0000+		
9	.1424+	.1011-	.0966-	.8870+	.0226-	.1351+	.7853+	.8929+	1.0000+	
10	.1427+	.3249-	.1193-	.0891+	.0096+	.0756+	.0468+	.0720+	.1933+	1.0000+
11	.1384+	.0952-	.0920-	.9116+	.0195-	.1388+	.8627+	.9149+	.9571+	.1878+
12	.2356+	.2038-	.1320-	.7715+	.0441-	.2123+	.6716+	.7705+	.8615+	.3571+
13	.1900+	.2010-	.1081-	.4975+	.0237-	.0086-	.2253+	.3818+	.4866+	.2164+
14	.1499+	.1557-	.0966-	.6037+	.0774-	.0117+	.2992+	.5333+	.5307+	.1501+
15	.1800+	.1983-	.0920-	.4146+	.1083-	.0265-	.1614+	.3084+	.3740+	.2045+
18	.1486+	.1747-	.0979-	.5106+	.0253-	.0002-	.2053+	.4038+	.4622+	.1912+
19	.1874+	.2244-	.0944-	.3558+	.0368-	.0388-	.1139+	.2167+	.3332+	.2549+
20	.0191-	.0265+	.0282+	.1064-	.0296+	.1306-	.0706-	.1317-	.2140-	.1266-
21	.0042-	.0192+	.0890+	.1066-	.0093+	.2739-	.0617-	.1693-	.2435-	.2032-
22	.0110-	.0684+	.0658+	.0314-	.0116-	.1100-	.0068-	.0855-	.0754-	.1026-
23	.2428+	.2409-	.1041-	.5686+	.0408-	.1231+	.4814+	.5503+	.5968+	.3174+
24	.1265+	.1195-	.0300+	.1512-	.0154-	.1237-	.0871-	.1689-	.2458-	.0033+
25	.1861+	.2403-	.0816-	.4129+	.0375-	.0596-	.1531+	.2738+	.3652+	.2371+
26	.1647+	.2107-	.0609-	.2335+	.0137-	.0586-	.0695+	.0838+	.2309+	.2140+
27	.1838+	.1804-	.1061-	.5344+	.0290-	.0156+	.2623+	.4540+	.5363+	.1953+
28	.0387-	.0534+	.0314-	.1697+	.0301+	.2538+	.1009+	.2079+	.2486+	.0688+
31	.1420+	.0999-	.0941-	.9110+	.0217-	.1353+	.8638+	.9124+	.9535+	.1941+
32	.0271+	.0075-	.0232+	.0174-	.0020-	.0782-	.1298+	.0264-	.0712-	.0164+
33	.0571-	.0379+	.0141-	.0773+	.0011+	.0419-	.0774+	.1979+	.0139+	.0849-
34	.1636+	.1500-	.0712-	.4253+	.0300-	.0167+	.4763+	.3659+	.4096+	.2251+

Table 7. (Continued)

Var.	11	12	13	14	17	18	19	20	21	22	23
11	1.0000+										
12	.8827+	1.0000+									
13	.4635+	.4966+	1.0000+								
14	.5207+	.5250+	.7683+	1.0000+							
17	.3593+	.4187+	.6672+	.8559+	1.0000+						
18	.4460+	.4775+	.8930+	.9062+	.7751+	1.0000+					
19	.3198+	.3953+	.7977+	.7417+	.8673+	.8613+	1.0000+				
20	.2100-	.2526-	.1277-	.1238-	.1126-	.1395-	.1317-	1.0000+			
21	.2369-	.3165-	.1493-	.1350-	.1249-	.1537-	.1391-	.7101+	1.0000+		
22	.0755-	.1129-	.0682-	.0538-	.0487-	.0662-	.0536-	.3122-	.1738+	1.0000+	
23	.5913+	.7265+	.4193+	.4273+	.3751+	.3861+	.3467+	.3178+	.0024+	.3380-	1.0000+
24	.2510-	.0408-	.2452-	.2058-	.1885-	.2248-	.2033-	.2588+	.3989+	.1513+	.2087+
25	.3401+	.4127+	.8641+	.7396+	.8213+	.8327+	.9054+	.1116-	.1385-	.0697-	.3762+
26	.2184+	.2889+	.6911+	.3997+	.5107+	.5833+	.7290+	.0856-	.0902-	.0334-	.2772+
27	.5120+	.5297+	.9517+	.7852+	.6333+	.8534+	.7131+	.1248-	.1451-	.0676-	.4309+
28	.2682+	.2587+	.0757+	.1773+	.1187+	.1308+	.0587+	.2110+	.0999-	.2992-	.3924+
31	.9989+	.8852+	.4692+	.5204+	.3621+	.4487+	.3257+	.2203-	.2421-	.0699-	.5856+
32	.1404+	.0588+	.0273-	.0501-	.0566-	.0379-	.0305-	.0127-	.1126+	.1048+	.0531-
33	.0494+	.0155+	.2423-	.0556+	.0710-	.0908-	.2801-	.2591+	.0184-	.4070-	.1231+
34	.5864+	.5181+	.4693+	.3519+	.3428+	.3854+	.4081+	.0918-	.0983-	.0419-	.3704+

Table 7. (Continued)

Var.	24	25	26	27	28	31	32	33	34
24	1.0000+								
25	.1767-	1.0000+							
26	.1540-	.7386+	1.0000+						
27	.2452-	.7656+	.5267+	1.0000+					
28	.2960-	.0303+	.0047-	.0941+	1.0000+				
31	.2491-	.3483+	.2258+	.5159+	.2501+	1.0000+			
32	.0094+	.0755-	.0226-	.0101-	.0251+	.1496+	1.0000+		
33	.0526+	.2172-	.4587-	.1533-	.0892+	.0453+	.1556+	1.0000+	
34	.1592-	.4067+	.3661+	.4643+	.0484+	.5967+	.6756+	.1187-	1.0000+

Table 8. All first order streams; n = 1069

Var.	1	2	3	4	5	6	7	8	9	10
1	1.0000+									
2	.2466-	1.0000+								
3	.0602+	.0451-	1.0000+							
4										
5	.0131-	.0465+	.0023+		1.0000+					
6	.3442-	.3301+	.1599-		.0693+	1.0000+				
7	.0104-	.0324-	.1157-		.0083-	.2133+	1.0000+			
8	.0221+	.0764-	.1309-		.0162+	.2525+	.7781+	1.0000+		
9	.0013+	.0493-	.1417-		.0063+	.3266+	.8768+	.9040+	1.0000+	
10	.0017-	.2902-	.1010-		.0026+	.0705+	.1254+	.2222+	.2113+	1.0000+
11	.0014-	.0450-	.1311-		.0086+	.3188+	.8622+	.8986+	.9752+	.2034+
12	.1972+	.2424-	.1270-		.0245-	.2774+	.4963+	.6206+	.6453+	.3874+
13										
14										
17										
18										
19										
20	.0238+	.0129+	.0073-		.0353+	.1179-	.4067-	.2909-	.4479-	.0657-
21	.0357+	.0085+	.0657+		.0019+	.2774-	.4108-	.5515-	.6106-	.1710-
22	.0035-	.0931+	.0698+		.0248-	.1119-	.1111-	.4139-	.2591-	.1405-
23	.1726+	.1993-	.0778-		.0155+	.1091+	.0835-	.1791+	.0478+	.2696+
24	.2073+	.1771-	.0022+		.0401-	.1377-	.2726-	.3297-	.3838-	.0792+
25										
26										
27										
28	.0148-	.0108+	.0350-		.0466+	.2319+	.0793+	.2695+	.3033+	.1083+
31	.0007+	.0494-	.1322-		.0055+	.3082+	.8841+	.8982+	.9767+	.2014+
32	.0394+	.0154-	.0862+		.0110-	.2187-	.1029-	.1884-	.2778-	.0752-
33	.0609+	.1016-	.0635-		.0166+	.1020-	.0941+	.4240+	.1008+	.0970+
34										

Table 8. (Continued)

Var.	11	12	13	14	17	18	19	20	21	22	23
11	1.0000+										
12	.6431+	1.0000+									
13											
14											
17											
18											
19											
20	.4213-	.2712-						1.0000+			
21	.5920-	.4556-						.6991+	1.0000+		
22	.2715-	.2464-						.3339-	.1665+	1.0000+	
23	.0685+	.5448+						.5542+	.1031+	.4458-	1.0000+
24	.4059-	.2756+						.2386+	.3772+	.1415+	.4792+
25											
26											
27											
28	.4060+	.2596+						.2553+	.0849-	.3186-	.4298+
31	.9912+	.6365+						.4617-	.6089-	.2414-	.0305+
32	.1443-	.1825-						.0327+	.2791+	.2261+	.1327-
33	.1458+	.1545+						.3556+	.0403-	.5906-	.3919+
34											

Table 8. (Continued)

Var.	24	25	26	27	28	31	32	33	34
24	1.0000+								
25									
26									
26									
28	.2696				1.0000+				
31	.3951-				.3461-	1.0000+			
32	.0904+				.0255+	.1176-	1.0000+		
33	.0117+				.0167+	.1440+	.2650+	1.0000+	
34									

Table 9. All second order streams; n = 253

Var.	1	2	3	4	5	6	7	8	9	10
1	1.0000+									
2	.3815-	1.0000+								
3	.0339+	.0747-	1.0000+							
4	.1143-	.1670+	.0910-	1.0000+						
5	.2973-	.5251+	.1217+	.0819+	1.0000+					
6	.3365-	.5819+	.0969-	.2480+	.7031+	1.0000+				
7	.0636-	.2124+	.1290-	.8381+	.0137+	.3114+	1.0000+			
8	.1134-	.1878+	.1077-	.9791+	.1121+	.2797+	.8497+	1.0000+		
9	.1117-	.2678+	.1339-	.8857+	.1279+	.3901+	.9250+	.8949+	1.0000+	
10	.2146+	.2194-	.0699-	.1148+	.0548-	.1215+	.1445+	.1014+	.1673+	1.0000+
11	.1285-	.2875+	.3151-	.8889+	.1312+	.3863+	.9221+	.8939+	.9712+	.1370+
12	.0534+	.0930+	.1682-	.7464+	.0611+	.4272+	.7812+	.7426+	.8063+	.3279+
13	.0242-	.0931+	.1213-	.5781+	.0313+	.0733+	.5053+	.5955+	.5929+	.0140-
14	.0283-	.0251+	.0998-	.7166+	.0681+	.0667+	.4139+	.7263+	.5450+	.0514+
17	.0410+	.0549-	.0471-	.4819+	.0279+	.0341-	.1589+	.4643+	.2608+	.0678+
18	.0557-	.0362+	.0976-	.7282+	.0461+	.0709+	.4790+	.7234+	.5956+	.0551+
19	.0055+	.0409-	.0446-	.4852+	.0015-	.0346-	.1957+	.4463+	.2808+	.0910+
20	.0409-	.1090-	.1439+	.3281-	.0866+	.1900-	.4326-	.3167-	.4607-	.2077-
21	.0096+	.1479-	.1437+	.4000-	.0743-	.2875-	.4259-	.3933-	.5369-	.2491-
22	.0539+	.1078-	.0119+	.3048-	.2487-	.2300-	.2183-	.3245-	.3416-	.1587-
23	.0715+	.0796-	.0396-	.2951+	.1712+	.2460+	.1403+	.2991+	.2183+	.1871+
24	.1824+	.2843-	.0368+	.3117-	.1551-	.1087-	.3090-	.3193-	.3960-	.1029+
25	.0058+	.1336-	.0435+	.5368+	.0866-	.1167-	.2159+	.4811+	.2963+	.0909+
26	.0172+	.0541-	.0753+	.0352-	.0574-	.1107-	.0787-	.1559-	.0790-	.0187+
27	.0137-	.1028+	.1180-	.4951+	.0731+	.1075+	.4745+	.5650+	.5456+	.0300-
28	.2180-	.3140+	.0182-	.5312+	.3352+	.3148+	.3489+	.5170+	.5134+	.0239-
31	.1137-	.2720+	.1400-	.8842+	.1093+	.3776+	.9367+	.8924+	.9720+	.1501+
32	.0242-	.0367+	.0539-	.0747-	.1205-	.1120-	.0376-	.0728-	.1583-	.0982-
33	.0122-	.0430-	.0658-	.6186+	.0164+	.0059-	.3275+	.6339+	.3897+	.0574+
34	.0124+	.0342-	.0671-	.2068+	.0689-	.0640-	.1970+	.2355+	.1495+	.0063-

Table 9. (Continued)

Var.	11	12	13	14	17	18	19	20	21	22
11	1.0000+									
12	.8034+	1.0000+								
13	.5351+	.3767+	1.0000+							
14	.5446+	.4212+	.5565+	1.0000+						
17	.2806+	.2522+	.1431+	.8076+	1.0000+					
18	.5820+	.4543+	.7069+	.9168+	.6121+	1.0000+				
19	.3022+	.2776+	.1556+	.7405+	.8387+	.7329+	1.0000+			
20	.4490-	.4161-	.1844-	.2041-	.1369-	.2644-	.2481-	1.0000+		
21	.5262-	.4697-	.2822-	.2495-	.1631-	.3035-	.2269-	.7562+	1.0000+	
22	.3443-	.3008-	.2384-	.1504-	.0609-	.1604-	.0199-	.2190-	.3403+	1.0000+
23	.2177+	.5461+	.1848+	.2121+	.1453+	.2015+	.0910+	.3833+	.0826+	.5039-
24	.4461-	.0090+	.3304-	.2436-	.1174-	.2769-	.1176-	.2152+	.4043+	.3082+
25	.2466+	.2856+	.4358+	.6138+	.6390+	.5821+	.5835+	.1298-	.2396-	.1682-
26	.0671-	.0000-	.0765-	.1313-	.1075-	.0331-	.0237+	.0089+	.0496+	.0985+
27	.4922+	.3348+	.8733+	.5060+	.1385+	.6004+	.1032+	.1485-	.2420-	.2622-
28	.6083+	.3984+	.1949+	.4414+	.3696+	.3561+	.2698+	.1014+	.1361-	.4096-
31	.9951+	.8117+	.5448+	.5310+	.2655+	.5767+	.2936+	.4707-	.5380-	.3287-
32	.0206-	.0820-	.0236-	.0665-	.0622-	.0474-	.0392-	.0099-	.0746+	.1404+
33	.4163+	.3420+	.5279+	.7338+	.7081+	.6619+	.5878+	.1249-	.2818-	.3105-
34	.2015+	.1332+	.4937+	.1056+	.1083-	.2226+	.0827-	.0577+	.1848-	.4238-

Table 9. (Continued)

Var.	23	24	25	26	27	28	31	32	33	34
23	1.0000+									
24	.3350+	1.0000+								
25	.2211+	.0546+	1.0000+							
26	.0443+	.1152+	.0618+	1.0000+						
27	.1395+	.3423-	.2787+	.3090-	1.0000+					
28	.4075+	.4312-	.0983+	.0089+	.1545+	1.0000				
31	.2019+	.4300-	.2557+	.0731-	.5033+	.5604+	1.0000+			
32	.1111-	.0839-	.1911-	.0013+	.0211+	.0377+	.0144-	1.0000+		
33	.2422+	.2542-	.7701+	.2590-	.5512+	.2959+	.4166+	.1389+	1.0000+	
34	.1831+	.2031-	.1537+	.0918-	.5086+	.0214-	.2168+	.5973+	.4413+	1.0000+

Table 10. All third order streams; n = 44

Var.	1	2	3	4	5	6	7	8	9	10
1	0.0000+									
2	.1951-	1.0000+								
3	.3469-	.0548+	1.0000+							
4	.0216+	.0499-	.0595-	1.0000+						
5	.0925-	.4766-	.0820-	.0052-	1.0000+					
6	.2139-	.5123+	.3065+	.3684+	.2082-	1.0000+				
7	.0690+	.0220-	.0597-	.8553+	.0234+	.3969+	1.0000+			
8	.0445+	.0329-	.0641-	.9851+	.0079-	.3959+	.8524+	1.0000+		
9	.0112+	.0268+	.0474-	.9271+	.0047-	.4848+	.9207+	.9174+	1.0000+	
10	.2019+	.3178-	.0802-	.3639-	.1571+	.2055-	.2605-	.3262-	.2965-	1.0000+
11	.0072-	.0179+	.0118+	.9429+	.0007-	.4949+	.8966+	.9290+	.9832+	.3260-
12	.0309-	.1278+	.0323-	.8740+	.0451-	.5787+	.9094+	.8807+	.9348+	.2743-
13	.0753+	.1294-	.0322-	.8734+	.0346+	.1839+	.5785+	.8598+	.7110+	.2460-
14	.0762+	.0608-	.1008-	.7549+	.1294-	.1706+	.3966+	.7621+	.5473+	.3376-
17	.0218-	.0455+	.0951-	.2753+	.3012-	.0590+	.0499+	.2628+	.1147+	.3798-
18	.0716+	.1272-	.0537-	.8651+	.0055-	.1598+	.5282+	.8505+	.6794+	.2830-
19	.0538-	.0941-	.0873-	.3899+	.1547-	.0643-	.1529+	.3498+	.2140+	.3251-
20	.1507+	.1120-	.0126-	.3944-	.0618-	.3484-	.4920-	.3847-	.5515-	.0974+
21	.0221+	.1981-	.0095-	.4219-	.0389+	.4909-	.4704-	.3987-	.6135-	.1553+
22	.1777-	.0617-	.1775+	.1116-	.0533+	.0869-	.0808-	.0902-	.1393-	.1305+
23	.0063+	.1293+	.0014+	.6010+	.1829-	.4474+	.3885+	.6111+	.5232+	.1921-
24	.0598-	.0462+	.2332-	.3771-	.0083+	.0787-	.2982-	.3308-	.4446-	.3192+
25	.0103-	.1164-	.2414-	.5808+	.0729-	.1362-	.3216+	.5114+	.3585+	.3555-
26	.1236-	.0684-	.1224+	.0050-	.0441+	.1399-	.0497-	.1417-	.0543-	.1228-
27	.0730+	.0704-	.0403-	.8669+	.0086+	.2871+	.6093+	.9060+	.7436+	.2156-
28	.1366-	.0786+	.2243+	.6726+	.0334-	.4605+	.4328+	.6529+	.6597+	.4175-
31	.0175-	.0165+	.0021+	.9492+	.0064-	.4864+	.9041+	.9345+	.9844+	.3254-
32	.1787-	.0371-	.3172+	.1337+	.0105-	.0516+	.0053+	.1001+	.0494-	.1067-
33	.0301-	.0300-	.1326-	.7926+	.1059-	.2007+	.5260+	.7959+	.6116+	.3752-
34	.1629+	.0791-	.0215+	.5018+	.1068-	.1925+	.3520+	.4625+	.4294+	.1020-

Table 10. (Continued)

Var.	11	12	13	14	17	18	19	20	21	22
11	1.0000+									
12	.9331+	1.0000+								
13	.7460+	.6195+	1.0000+							
14	.5970+	.5139+	.8163+	1.0000+						
17	.1619+	.1731+	.2016+	.6928+	1.0000+					
18	.7233+	.6098+	.9640+	.8866+	.3617+	1.0000+				
19	.2579+	.2704+	.3435+	.6239+	.7619+	.5524+	1.0000+			
20	.5335-	.5116-	.1806-	.1220-	.0337+	.1265-	.1069+	1.0000+		
21	.5935-	.5625-	.2216-	.1780-	.0574-	.2109-	.0748-	.6526	1.0000+	
22	.1308-	.1376-	.0955-	.1248-	.1677-	.1296-	.2378-	.3928-	.3025+	1.0000+
23	.5619+	.6195+	.6008+	.5729+	.2866+	.6741+	.4689+	.1975+	.1867-	.3902-
24	.4614-	.2260-	.3722-	.2890-	.0897-	.3217-	.0687-	.4305+	.6142+	.1790+
25	.3710+	.3252+	.6070+	.7123+	.6175+	.6756+	.7128+	.0561+	.0059-	.2186-
26	.0550-	.1125-	.0716+	.1760-	.2273-	.0187+	.0311-	.0286-	.0525-	.0224-
27	.7707+	.6806+	.9362+	.8282+	.2301+	.9144+	.3027+	.2407-	.2750-	.0762-
28	.7437+	.5993+	.5922+	.5913+	.3061+	.6363+	.3286+	.3171-	.4153-	.1321-
31	.9982+	.9353+	.7530+	.6004+	.1615+	.7285+	.2646+	.5307-	.5912-	.1339-
32	.1035+	.0709+	.1919+	.2402+	.2394+	.2272+	.2810+	.0832+	.1324+	.0656+
33	.6552+	.6178+	.7462+	.9093+	.6950+	.8206+	.6895+	.1342-	.1910-	.1746-
34	.4677+	.3978+	.6083+	.4357+	.1164+	.5983+	.3278+	.2161+	.3048-	.4886-

Table 10. (Continued)

Var.	23	24	25	26	27	28	31	32	33	34
23	1.0000+									
24	.0837+	1.0000+								
25	.3614+	.2127-	1.0000+							
26	.1355-	.1079-	.1848+	1.0000+						
27	.6193+	.3218-	.4606+	.2142-	1.0000+					
28	.5822+	.4626-	.2484+	.1071-	.6196+	1.0000+				
31	.5614+	.4586-	.3906+	.0425-	.7731+	.7263+	1.0000+			
32	.1917+	.0535-	.1757+	.0836+	.1008+	.3163+	.1121+	1.0000+		
33	.5855+	.2682-	.8003+	.2597-	.7760+	.5823+	.6620+	.2625+	1.0000+	
34	.6709+	.3273-	.4276+	.0988+	.4999+	.2991+	.4771+	.2416+	.4444+	1.0000+

Table 11. All fourth order streams; n = 8

Var.	1	2	3	4	5	6	7	8	9	10
1	1.0000+									
2										
3	.2119-		1.0000+							
4	.3179+		.0773+	1.0000+						
5	.1804-		.9198+	.1681+	1.0000+					
6	.5291-		.5050+	.5989-	.5180+	1.0000+				
7	.4307+		.2883-	.0590+	.2689-	.0303-	1.0000+			
8	.3922+		.1049+	.9789+	.1352+	.6551-	.1215+	1.0000+		
9	.2738+		.2016+	.8328+	.3791+	.4323-	.1471+	.8238+	1.0000+	
10	.5996-		.4795+	.6767-	.4506+	.9733+	.2083-	.7323-	.5694-	1.0000+
11	.5079+		.0567-	.4584+	.0582+	.1868-	.8595+	.5005+	.6136+	.4020-
12	.0686-		.1487+	.1589+	.4296+	.4712+	.4503+	.0465_	.3595+	.2854+
13	.3636+		.1646-	.8463+	.1291-	.8253-	.1503+	.8897+	.8167+	.8885-
14	.3825+		.1340+	.6965+	.0769+	.5801-	.2855-	.7133+	.4681+	.5449-
17	.2498+		.2850+	.3281+	.1863+	.1894-	.4708-	.3199+	.0437+	.1002-
18	.3786+		.1822-	.8786+	.1655-	.8890-	.0525-	.9041+	.7023+	.8981-
19	.2081+		.0756-	.5816+	.1113-	.6049-	.5353-	.5500+	.1609+	.4868-
20	.1707+		.3530+	.1185+	.2031+	.3638-	.5903-	.2097+	.1674+	.2524-
21	.0824+		.4152+	.1624+	.3107+	.2869-	.7355-	.2111+	.1717+	.1638-
22	.5862-		.1463-	.0198+	.0517+	.4213+	.0579-	.1586-	.0809-	.3949+
23	.3464+		.6337+	.4402+	.7175+	.0839-	.1067-	.4753+	.7163+	.1716-
24	.8115-		.2711+	.3774-	.3159+	.6480+	.6416-	.5082-	.3913-	.7467+
25	.1405+		.5131-	.5639+	.1113-	.5450-	.5726-	.4872+	.1994+	.4365-
26	.4395-		.1112-	.k805-	.1943+	.4748+	.2342-	.3723=	.0737-	.4577+
27	.3977+		.0682-	.7916+	.1202-	.7900-	.2279+	.8790+	.7459+	.8525-
28	.4243+		.2858+	.7310+	.4343+	.2904-	.4081+	.7558+	.9283+	.4721-
31	.5161+		.1047-	.4244+	.0149+	.1682-	.8866+	.4606+	.5584+	.3822-
32	.2136+		.4054-	.4308-	.5299-	.1562+	.7997+	.3518-	.4429-	.0876+
33	.5105+		.4008-	.0445+	.6014-	.3201-	.4132+	.1172+	.3659-	.2925-
34	.2654+		.3925-	.4153-	.5276-	.1176+	.8044+	.3246-	.4196-	.0488+

Table 11. (Continued)

Var.	11	12	13	14	17	18	19	20	21	22
11	1.0000+									
12	.5803+	1.0000+								
13	.4735+	.1072-	1.0000+							
14	.0242-	.3295-	.6387+	1.0000+						
17	.3533-	.3532-	.1405+	.8512+	1.0000+					
18	.2690+	.2547-	.9450+	.7436+	.3192+	1.0000+				
19	.3410-	.4648-	.4100+	.7211+	.6639+	.6824+	1.0000+			
20	.3979-	.6964-	.2958+	.6074+	.5744+	.3656+	.4123+	1.0000+		
21	.4990-	.6176-	.2337+	.6411+	.6618+	.3483+	.5140+	.9706+	1.0000+	
22	.0937-	.6084+	.2696-	.2797-	.1754-	.2465-	.0664-	.7036-	.5408-	1.0000+
23	.3117+	.1690+	.4022+	.4809+	.3377+	.3137+	.0367+	.5616+	.5678+	.4281-
24	.7044-	.1229+	.5864-	.1943-	.1435+	.5048-	.0325-	.0779-	.0943+	.6486+
25	.3728-	.3314-	.3966+	.7673+	.7251+	.6393+	.9371+	.3670+	.4983+	.1128+
26	.2057-	.6116+	.4079-	.3504-	.1775-	.3918-	.1619-	.4895-	.3139-	.8282+
27	.5030+	.1988-	.9677+	.6306+	.1529+	.9001+	.3544+	.3469+	.2476+	.4175-
28	.8131+	.4756+	.6843+	.3059+	.0722-	.5330+	.0360-	.0305+	.0031-	.1855-
31	.9961+	.5970+	.4259+	.0657-	.3734-	.2307+	.3475-	.4607-	.5588-	.0569-
32	.3849+	.0901+	.2653-	.4411-	.3901-	.4003-	.5742-	.5281-	.6843-	.0725-
33	.1284+	.3301-	.0320+	.2372+	.2939+	.1370+	.2768+	.1497-	.2312-	.2212-
34	.4001+	.0527+	.2310-	.4014-	.3628-	.3688-	.5622-	.4712-	.6378-	.1440-

Table 11. (Continued)

Var.	23	24	25	26	27	28	31	32	33	34
23	0.0000+									
24	.2229-	1.0000+								
25	.0605+	.1285+	1.0000+							
26	.1776-	.6854+	.0741+	1.0000+						
27	.4070+	.6727-	.2829+	.6099-	1.0000+					
28	.7273+	.5553-	.0607-	1885-	.6734+	1.0000+				
31	.2452+	.6984-	.3794-	.1754-	.4526+	.7690+	1.0000+			
32	.5010-	.3638-	.6104-	.2549-	.1420-	.1971-	.4329+	1.0000+		
33	.4337-	.4544-	.1688+	.5018-	.1471+	.2329-	.1741+	.6109+	1.0000+	
34	.4544-	.4141-	.6062-	.3129-	.0992-	.1693-	.4444+	.9971+	.6258+	1.0000+

APPENDIX B

Raw Data

Table 12. Raw data

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1	1112233445	117	38.88	102.49	12.0	2.3	14.8	17.6	6.2	225
2	1112233445	45	38.83	102.48	9.0	4.8	13.0	17.6	5.1	225
3	112233445	125	38.88	102.43	4.0	3.7	8.7	15.2	3.8	200
4	112233445	75	38.82	102.41	8.0	6.8	12.9	11.0	5.5	175
5	112233445	115	38.87	102.36	5.3	4.6	11.5	6.1	5.1	150
6	112233445	136	38.86	102.31	1.5	1.8	7.1	3.2	3.1	125
8	1112233445	133	38.95	102.54	2.0	2.1	6.9	24.0	2.8	175
9	1112233445	108	38.94	102.55	2.8	2.8	7.4	24.0	3.1	175
10	112233445	129	38.96	102.48	3.5	4.0	10.0	18.7	4.2	150
11	112233445	78	38.91	102.44	3.0	3.7	10.4	14.2	4.3	200
12	112233445	92	38.89	102.40	7.5	3.4	16.1	6.8	4.9	200
14	111233445	158	38.93	102.25	5.8	3.8	10.2	2.3	4.4	225
15	111233445	108	38.91	102.30	15.0	8.0	17.7	2.3	7.3	275
18	111233445	133	39.01	102.31	5.0	3.1	13.1	11.1	4.8	325
19	111233445	105	39.00	102.32	6.5	3.9	11.3	11.1	4.9	325
20	11233445	88	39.97	102.36	25.0	14.2	26.3	10.8	11.1	350
21	11233445	148	39.01	102.26	3.3	3.6	8.8	8.0	3.8	175
22	11233445	173	39.01	102.24	2.0	3.2	7.2	7.7	3.5	175
23	112233445	172	39.01	102.21	2.8	4.0	9.3	3.4	4.2	150
25	1112233445	104	38.96	102.21	4.3	3.3	9.6	.2	4.3	175
26	1112233445	54	38.93	102.20	2.0	2.8	8.4	.2	3.2	175
28	1133445	160	38.98	102.18	2.8	5.6	11.2	10.7	5.4	200
29	1133445	67	38.92	102.18	3.5	3.8	9.6	8.6	4.0	225
30	1133445	133	38.96	102.15	3.8	3.9	11.5	5.0	5.2	225
32	11445	136	38.96	102.08	18.8	10.0	23.3	16.9	10.2	325
33	21445	4	38.89	101.94	1.5	1.9	5.1	11.8	2.2	175
34	1112445	155	39.02	102.09	1.8	1.8	6.2	15.4	2.3	150
35	1112445	103	39.01	102.10	2.5	2.6	7.9	15.4	3.3	175
36	112445	153	38.99	102.00	9.5	6.3	15.3	7.3	6.6	325
37	412445	144	38.96	101.95	2.8	1.2	9.4	3.5	4.3	525
39	41445	138	38.96	101.91	3.8	4.2	15.8	7.2	6.5	700
41	1112233445	84	39.05	102.08	19.0	11.1	23.7	2.0	9.9	250
42	1112233445	104	39.07	102.04	1.8	1.9	7.3	2.0	3.2	150
43	112233445	129	39.08	102.02	2.5	1.6	7.7	1.4	3.1	150
45	1112233445	68	39.04	102.06	2.3	3.1	7.2	4.1	3.0	100
46	1112233445	28	39.04	102.04	1.5	1.4	5.0	4.1	1.9	75
48	111233445	123	39.09	102.00	1.3	1.0	5.8	1.6	2.7	150

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
49	111233445	180	39.09	101.98	1.3	1.2	5.2	1.6	2.0	100
51	4133445	31	39.04	101.97	1.3	1.7	4.6	17.4	2.0	100
52	4133445	49	39.03	101.95	.5	1.4	4.2	16.9	1.5	150
53	4133445	159	39.07	101.95	1.8	3.2	8.3	15.8	3.8	150
54	4133445	22	39.02	101.93	2.3	3.2	7.2	15.1	3.0	250
55	4133445	143	39.05	101.93	.8	1.7	4.8	14.0	2.2	225
56	4133445	142	39.06	101.92	1.0	2.6	6.0	13.2	2.7	225
57	4133445	148	39.06	101.90	2.5	2.4	7.2	11.1	3.1	175
58	4133445	157	39.06	101.88	1.5	2.0	5.5	10.2	2.6	150
59	4133445	148	39.05	101.87	1.3	1.6	5.1	9.1	2.3	175
60	4133445	45	39.02	101.86	1.5	1.2	5.7	7.5	2.0	150
61	4133445	169	39.04	101.84	1.5	2.0	5.3	6.7	2.1	150
62	2133445	204	39.01	101.81	1.3	5.7	6.2	1.9	2.3	175
64	1112233445	125	39.01	101.95	4.3	2.6	8.9	4.2	3.8	200
65	1112233445	101	39.00	101.95	2.8	1.9	7.9	4.2	3.7	200
69	2112445	159	39.00	101.79	1.1	2.1	6.3	2.0	3.0	175
70	2112445	189	39.01	101.78	3.0	2.8	7.3	2.0	3.1	175
72	41445	100	38.97	101.88	10.8	9.7	22.9	2.1	10.4	475
74	41125	88	38.86	101.86	16.8	6.4	26.4	10.0	11.1	325
75	41125	346	38.84	101.81	2.0	2.2	6.0	10.0	2.7	200
76	4125	26	38.85	101.79	2.0	3.8	7.9	7.6	3.2	200
77	4125	8	38.86	101.72	3.0	3.0	8.1	4.8	3.2	175
79	41125	96	38.83	101.72	6.8	4.9	13.1	7.4	6.1	325
80	41125	59	38.80	101.72	15.0	5.5	18.3	7.4	7.6	325
82	2112235	133	39.01	101.74	1.5	2.3	5.7	2.0	2.5	200
83	2112235	166	39.01	101.73	1.0	1.8	4.8	2.0	2.2	200
84	2122350	92	38.99	101.74	1.8	2.7	7.7	1.2	3.4	225
86	2112235	140	39.01	101.71	1.0	1.8	4.6	1.7	2.0	200
87	2112235	185	39.01	101.70	1.3	1.6	4.7	1.7	2.0	200
89	2135	174	39.00	101.68	3.8	4.4	11.0	9.0	4.7	250
90	2135	121	38.96	101.71	5.3	2.2	9.4	7.1	3.8	300
91	211235	150	39.01	101.68	1.5	2.2	6.2	6.2	2.6	150
92	211235	205	39.01	101.66	1.3	1.6	5.1	6.2	2.0	150
93	21235	210	38.99	101.64	1.3	1.9	5.8	4.7	2.2	175
94	21235	202	38.97	101.63	1.6	2.7	6.6	2.3	2.8	200
97	215	19	38.86	101.61	8.5	5.3	13.2	386.2	5.9	375
98	215	349	38.86	101.55	3.8	4.1	10.7	383.9	5.0	375
99	215	356	38.86	101.54	4.0	4.9	10.9	382.8	5.0	375
100	21125	126	38.97	101.61	3.5	4.1	11.1	5.4	5.0	300
101	21125	161	38.98	101.59	4.5	2.8	11.0	5.4	4.8	300
103	215	352	38.86	101.51	5.0	3.9	12.0	381.0	5.2	325
104	215	139	38.97	101.54	24.0	12.3	26.2	377.8	11.5	425
105	111223345	101	39.08	101.93	1.8	5.5	11.6	10.7	5.0	150
106	111223345	129	39.10	101.93	5.8	2.6	8.4	10.7	3.7	125

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
107	11223345	139	39.09	101.89	3.8	2.7	8.5	8.6	3.9	150
108	11223345	130	39.06	101.80	2.3	2.4	8.2	2.0	3.8	100
109	21223345	346	39.04	101.76	1.5	2.1	5.3	.8	2.2	150
111	111223345	84	39.11	101.90	3.8	5.3	12.5	9.0	5.8	150
112	111223345	107	39.13	101.89	3.3	3.9	9.1	9.0	3.7	125
113	11223345	121	39.14	101.86	2.8	4.1	9.9	6.9	4.5	150
114	11223345	148	39.13	101.83	.8	1.8	4.7	6.7	2.1	100
115	11223345	115	39.10	101.83	5.0	5.8	12.8	2.8	5.7	175
117	113345	138	39.10	101.78	4.5	5.0	12.0	8.3	5.4	200
118	213345	356	39.05	101.73	.6	1.7	4.2	7.8	1.6	150
119	11123345	114	39.14	101.81	6.8	7.0	16.3	8.7	6.9	150
120	11123345	157	39.15	101.80	1.0	2.0	6.9	8.7	3.4	125
121	1123345	157	39.15	101.77	3.5	3.5	7.3	6.7	3.0	150
122	1123345	191	39.14	101.75	1.5	2.0	6.1	5.4	2.4	125
123	1123345	211	39.12	101.73	1.0	1.6	5.0	4.1	2.0	125
124	1123345	130	39.11	101.77	3.8	3.6	10.2	2.0	4.0	175
126	413345	165	39.10	101.69	2.0	3.3	8.1	6.5	4.0	200
127	213345	30	39.04	101.72	5.0	4.1	9.9	5.8	4.0	200
128	413345	168	39.11	101.70	4.3	5.7	12.3	5.0	5.8	250
129	213345	170	39.14	101.68	1.5	2.2	7.1	3.8	3.0	150
130	21123345	35	39.05	101.68	2.0	2.2	6.8	.2	2.7	150
131	21123345	21	39.05	101.66	.8	1.0	3.8	.2	1.6	150
133	213345	162	39.13	101.66	.9	1.8	4.5	2.7	2.0	200
135	411223345	125	39.11	101.68	1.5	2.6	8.1	.2	3.5	200
136	411223345	148	39.11	101.66	1.0	1.7	5.1	.2	2.3	150
138	111223345	125	39.13	101.68	1.0	2.5	5.8	1.8	2.7	150
139	111223345	178	39.13	101.66	.8	1.3	4.0	1.8	1.8	100
142	411245	150	39.12	101.63	2.8	3.1	8.5	3.0	3.8	225
143	411245	190	39.11	101.62	2.3	1.4	5.8	3.0	2.4	225
145	411245	172	39.10	101.60	1.8	2.0	5.9	1.8	2.8	225
146	411245	209	39.09	101.58	1.3	1.0	4.7	1.8	1.7	150
148	4145	191	39.07	101.57	1.5	2.6	6.1	23.1	2.8	250
149	4145	211	39.06	101.56	1.3	2.0	6.0	22.3	2.9	250
150	211245	41	39.02	101.63	1.3	2.2	6.0	4.2	2.3	225
151	211245	90	39.03	101.65	4.5	2.2	7.5	4.2	3.0	225
152	21245	68	39.02	101.61	2.0	2.0	5.4	1.8	2.0	200
154	2145	194	39.04	101.56	.8	1.4	4.7	20.8	2.0	150
155	211245	66	39.01	101.57	1.8	1.4	6.3	.6	2.3	200
156	211245	0	39.01	101.56	.8	.6	3.3	.6	1.2	125
158	2145	9	39.01	101.55	.7	1.7	4.0	18.9	1.7	150
159	211245	158	39.05	101.55	1.3	1.6	7.2	1.6	3.4	250
160	211245	183	39.06	101.54	1.3	2.3	6.0	1.6	2.8	250
162	2145	177	39.05	101.52	3.0	3.5	9.6	15.7	4.2	275

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
163	211245	164	39.06	101.50	1.8	1.1	4.2	2.8	1.7	125
164	211245	214	39.06	101.49	1.2	1.2	4.0	2.8	1.6	125
166	2145	183	39.04	101.49	2.5	4.1	9.7	13.3	4.5	225
167	2145	186	39.02	101.47	4.8	4.3	10.6	10.6	4.7	250
169	111223345	102	39.02	102.76	3.8	4.1	10.0	9.8	4.2	175
170	111223345	144	39.04	102.75	3.5	4.1	10.0	9.8	4.0	175
171	11223345	149	39.02	102.71	1.3	2.0	6.5	7.1	3.0	100
172	11223345	355	38.98	102.71	2.0	2.3	6.9	2.7	2.6	75
174	111223345	156	39.05	102.70	1.3	1.6	5.6	5.5	2.2	100
175	111223345	97	39.04	102.71	1.8	1.4	4.4	5.5	1.7	75
176	11223345	136	39.05	102.67	1.3	1.4	5.1	3.4	2.2	75
178	11123345	92	39.06	102.67	3.3	3.7	9.9	4.8	3.8	125
179	11123345	141	39.08	102.65	3.8	2.4	7.2	4.8	2.9	75
180	1123345	66	39.04	102.63	1.3	1.7	6.0	3.0	2.5	125
182	11123345	5	39.00	102.56	2.3	2.2	11.0	.7	5.2	125
183	11123345	27	38.99	102.58	7.8	7.0	16.0	.7	6.9	125
185	11123345	114	39.07	102.61	8.3	6.9	15.0	.8	6.5	200
186	11123345	144	39.08	102.50	8.3	4.1	10.7	.8	4.6	150
188	113345	123	39.09	102.55	5.3	3.1	10.1	106.5	4.1	175
189	11123345	145	39.09	102.53	2.8	3.2	8.0	.2	3.4	150
190	11123345	170	39.10	102.52	1.7	2.0	6.9	.2	2.8	150
192	113345	166	39.09	102.50	2.8	2.8	7.4	104.0	3.0	150
193	113345	159	39.09	102.46	2.5	2.4	8.1	100.2	3.3	125
194	11123345	39	39.00	102.54	3.0	4.1	8.6	7.5	3.9	125
195	11123345	8	38.99	102.53	2.0	3.8	7.3	7.5	3.0	125
196	1123345	355	39.00	102.51	2.3	2.3	7.2	6.8	3.0	125
197	1123345	26	39.02	102.50	2.0	3.2	8.3	4.1	3.9	100
198	1123345	43	39.03	102.46	4.8	4.2	11.3	.6	5.0	175
200	11123345	67	39.01	102.45	2.5	2.1	8.7	4.3	3.8	150
201	11123345	42	38.99	102.46	11.3	7.7	15.8	4.3	7.0	250
203	113345	5	39.02	102.37	8.8	7.3	16.2	93.4	6.8	250
204	113345	126	39.10	102.38	2.2	2.8	9.2	90.9	4.2	150
205	113345	137	39.12	102.35	4.3	4.2	11.7	87.8	4.8	200
206	113345	34	39.05	102.33	8.3	4.1	7.8	85.8	5.5	200
207	113345	106	39.15	102.18	3.5	4.3	9.7	71.9	5.3	125
208	113345	135	39.17	102.15	4.3	2.8	10.2	70.0	4.3	125
209	113345	136	39.16	102.13	2.8	1.8	6.5	69.2	2.6	75
210	11123345	87	39.16	102.05	7.5	4.0	16.0	2.0	6.8	125
211	11123345	128	39.18	102.01	3.0	2.6	9.1	2.0	3.6	100
213	11123345	59	39.08	102.12	17.5	16.1	25.8	10.2	12.9	250
214	11123345	74	39.09	102.15	25.0	15.2	29.7	10.2	11.4	225
216	113345	21	39.16	101.88	1.8	1.1	6.0	48.0	2.3	75
217	113345	111	39.20	101.94	10.3	6.5	16.3	47.2	7.4	125
218	11123345	66	39.14	102.32	9.5	8.0	16.0	38.3	7.4	250

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
219	11123345	112	39.16	102.29	3.3	3.8	8.5	38.3	3.6	100
220	1123345	134	39.18	102.27	3.0	2.5	6.8	37.2	2.3	100
221	1123345	41	39.15	102.25	3.0	2.5	6.1	36.2	3.2	75
223	113345	22	39.17	101.86	.5	1.8	4.5	45.8	2.0	50
224	113345	29	39.16	101.83	.5	2.1	5.2	43.1	2.0	75
225	113345	134	39.21	101.83	3.0	2.1	8.2	40.9	4.0	75
226	113345	147	39.23	101.82	4.1	1.8	11.1	40.3	4.8	75
227	413345	6	39.17	101.76	.8	2.1	4.7	35.7	1.9	75
228	413345	124	39.22	101.77	4.5	2.9	12.1	33.2	5.8	75
229	413345	148	39.23	101.75	2.8	1.6	9.9	33.1	4.6	75
230	413345	154	39.23	101.72	4.5	3.5	11.5	31.7	4.6	75
231	213345	78	39.18	101.71	.8	2.9	5.6	29.1	2.2	75
232	413345	159	39.23	101.68	2.0	2.8	8.0	27.7	3.4	75
233	413345	176	39.19	101.66	1.3	1.5	6.0	27.1	2.7	75
234	413345	82	39.17	101.69	6.3	4.8	12.1	26.4	5.4	100
235	413345	50	39.15	101.66	2.3	2.8	7.7	25.8	3.2	125
236	413345	79	39.18	101.65	3.3	3.5	10.3	25.0	5.2	100
237	413345	19	39.15	101.64	.5	1.3	3.6	24.2	1.3	75
238	41123345	147	39.19	101.64	2.1	2.1	8.0	1.0	3.5	90
239	41123345	174	31.19	101.63	1.7	1.5	7.0	1.0	3.2	90
241	213345	28	39.14	101.62	.5	1.8	4.5	21.6	1.8	75
242	213345	32	39.14	101.60	.5	2.1	4.1	21.4	1.9	75
243	413345	175	39.18	101.60	2.8	4.0	8.9	21.2	4.0	100
244	213345	30	39.14	101.60	.5	1.3	4.1	19.2	1.9	75
245	413345	39	39.12	101.58	2.5	1.9	6.0	17.1	1.9	100
246	413345	38	39.11	101.55	1.5	1.3	5.4	14.7	2.2	75
247	413345	340	39.11	101.54	2.0	1.3	4.8	14.6	1.6	75
248	41123345	112	39.16	101.56	4.4	2.2	8.8	2.9	3.6	125
249	41123345	164	39.17	101.55	4.0	1.4	5.2	2.9	2.2	100
250	4123345	197	39.17	101.53	4.0	1.6	5.6	2.5	2.0	100
252	413345	157	39.16	101.51	1.3	4.0	9.7	10.2	4.2	125
253	413345	167	39.15	101.49	2.5	2.3	7.8	9.1	3.5	100
254	213345	176	39.14	101.47	.5	1.4	4.9	7.7	2.0	125
255	213345	190	39.14	101.45	2.3	2.3	8.4	7.1	3.7	125
256	213345	212	39.12	101.44	.5	1.1	3.3	5.7	1.5	75
257	41123345	73	39.09	101.50	7.8	6.2	12.3	2.1	5.1	125
258	21123345	128	39.11	101.48	.8	1.0	3.6	2.1	1.7	100
259	2123345	8	39.09	101.46	2.3	1.0	3.6	1.8	1.4	100
261	213345	183	39.11	101.42	2.0	1.9	5.7	3.7	2.0	100
263	111223345	109	39.20	101.60	5.0	3.6	9.8	13.1	4.5	65
264	111223345	173	39.21	101.57	3.3	2.4	7.4	13.1	2.7	65
265	11223345	162	39.21	101.54	2.0	2.5	6.7	11.1	3.0	65
266	11223345	152	39.21	101.53	1.8	2.5	6.5	10.1	3.0	65
267	11223345	166	39.20	101.51	3.5	2.3	7.1	8.9	3.0	65

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D-		R
268	11223345	164	39.20	101.50	2.0	2.2	6.8	7.5	2.6	65
269	41223345	150	39.18	101.45	1.5	2.0	6.8	4.0	3.0	65
270	41223345	152	39.18	101.43	2.0	3.5	9.0	2.1	4.0	65
272	211223345	137	39.14	101.44	1.0	1.5	6.4	1.8	2.6	60
273	211223345	180	39.14	101.43	1.0	1.6	5.1	1.8	2.0	60
275	413345	195	39.12	101.39	.8	1.2	4.3	6.1	2.0	85
276	413345	230	39.10	101.37	1.5	1.2	5.2	5.0	2.0	110
277	413345	255	39.09	101.36	3.3	1.4	8.1	4.0	2.8	110
278	413345	255	39.07	101.37	1.3	1.4	4.9	1.6	2.2	85
280	211245	111	39.04	101.45	3.8	4.9	11.2	2.2	5.1	150
281	211245	137	39.05	101.44	4.3	3.1	9.6	2.2	4.2	150
283	411245	182	39.05	101.36	1.3	1.4	5.8	1.5	2.6	100
284	411245	208	39.06	101.34	2.8	2.0	8.8	1.5	3.7	100
286	2145	72	39.01	101.37	1.0	2.0	5.8	9.8	2.1	65
287	411245	186	39.05	101.00	1.5	2.0	6.3	3.0	2.7	75
288	411245	205	39.04	101.00	1.5	2.1	6.4	3.0	2.7	75
290	41245	195	39.03	101.34	2.5	3.7	9.1	1.1	4.1	125
292	4145	202	39.01	101.31	4.0	3.8	9.1	6.6	4.0	225
293	4145	184	39.00	101.28	9.0	9.3	17.0	1.6	8.1	325
295	21125	60	38.87	101.30	4.5	3.0	7.9	2.4	3.1	325
296	21125	342	38.86	101.27	2.0	2.0	5.2	2.4	2.2	275
298	11125	137	39.04	101.27	1.5	2.8	8.0	9.2	3.0	150
299	11125	170	39.04	101.26	1.0	1.6	5.2	9.2	2.4	150
300	1125	173	39.04	101.25	.8	2.0	4.8	8.4	2.4	125
301	1125	190	39.03	101.24	.8	1.2	4.4	8.3	1.9	125
302	4125	132	39.02	101.26	1.0	1.4	4.5	7.2	1.9	100
304	2150	18	38.88	101.25	3.5	3.8	8.6	357.0	4.0	350
305	41125	157	38.97	101.21	17.3	10.2	21.3	.4	9.8	350
306	21125	175	38.96	101.18	11.3	7.4	16.9	.4	7.8	300
308	215	20	38.97	101.18	2.8	4.2	8.9	352.5	4.4	325
309	215	15	38.86	101.16	5.8	4.0	10.9	351.4	4.5	325
310	215	13	38.85	101.13	5.0	5.2	11.4	350.0	4.8	325
311	215	169	38.95	101.12	10.0	5.6	15.1	349.0	8.0	400
312	11125	110	39.03	101.19	7.0	5.0	14.6	15.0	6.8	150
313	11125	150	39.04	101.17	2.3	2.9	8.3	15.0	3.7	125
314	1125	166	39.03	101.14	1.0	1.3	6.0	12.9	2.4	150
315	1125	167	39.03	101.12	2.5	2.3	6.7	11.3	2.7	150
316	4125	130	38.99	101.13	3.9	4.1	10.0	7.8	4.6	250
318	41125	175	38.95	101.01	9.8	5.6	15.3	3.5	7.0	400
319	41125	217	38.93	100.94	6.5	5.0	12.7	3.5	4.8	350
320	4125	161	38.93	101.04	7.8	4.2	16.8	1.1	8.0	400
322	215	174	38.87	100.95	4.0	4.0	11.0	336.9	5.1	275
323	21125	185	38.90	100.92	3.0	2.6	8.9	4.4	3.9	225
324	21125	217	38.89	100.90	1.3	3.2	8.6	4.4	3.2	225
325	2125	160	38.86	100.94	2.3	3.8	9.0	2.0	4.1	200

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
327	215	177	38.85	100.89	5.0	5.0	12.0	331.2	5.8	0
328	111223345	73	38.72	102.51	3.8	2.8	10.5	27.2	4.2	150
329	111223345	116	38.75	102.48	12.5	6.0	16.9	27.2	6.7	225
330	112233450	104	38.71	102.26	9.3	4.9	14.9	12.7	7.2	175
332	111223345	104	38.71	102.07	19.8	8.2	22.5	1.5	10.3	250
333	111223345	137	38.73	102.03	12.3	5.8	14.5	1.5	6.6	175
335	11123345	91	38.75	101.94	16.5	8.4	21.0	10.0	9.5	250
336	11123345	118	38.77	101.91	11.5	6.1	16.5	10.0	7.7	200
338	11123345	103	38.77	102.46	7.5	3.9	12.5	66.7	5.9	100
339	11123345	141	38.80	102.47	11.5	7.1	17.0	66.7	7.2	150
340	1123345	123	38.79	102.40	7.0	5.5	11.5	61.5	5.2	250
341	1123345	34	38.83	102.21	13.8	6.5	17.0	47.5	6.0	220
342	1123345	94	38.76	102.26	33.0	18.8	34.2	43.3	15.0	450
343	1123345	69	38.77	102.03	30.0	12.5	30.0	32.8	12.2	225
345	113345	114	38.62	101.54	5.8	3.2	13.9	76.9	6.0	125
346	11123345	104	38.62	101.68	79.8	15.0	43.5	2.7	19.9	325
347	11123345	130	38.61	101.55	2.3	2.2	11.8	2.7	5.4	125
349	113345	77	38.55	101.50	19.0	4.1	24.0	69.0	10.9	200
350	113345	115	38.65	101.36	67.5	10.6	40.0	52.0	17.1	245
351	413345	96	38.62	100.98	7.5	5.1	18.0	13.9	8.2	275
352	413345	69	38.65	101.07	44.5	7.3	37.5	7.0	17.3	450
353	11123345	96	38.73	101.52	74.8	17.3	50.5	34.8	22.9	375
354	11123345	160	38.73	101.33	3.0	2.2	8.9	34.8	4.3	150
355	1123345	136	38.73	101.29	3.3	3.0	8.5	30.3	4.0	200
356	1123345	160	38.73	101.25	1.3	2.1	5.9	28.4	2.4	140
357	1123345	142	38.74	101.22	4.3	3.0	9.5	24.5	3.8	175
358	1123345	54	38.67	101.24	20.0	5.1	23.5	22.5	9.8	275
359	4123345	29	38.69	101.07	4.0	3.3	9.5	11.0	4.2	225
360	4123345	15	38.69	101.01	6.5	2.2	12.5	6.8	5.4	300
361	4123345	9	38.72	100.95	2.5	2.3	6.1	3.8	3.1	275
372	411223345	142	38.83	101.45	7.5	5.6	15.0	8.8	6.0	250
373	411223345	101	38.81	101.48	8.8	7.0	15.9	8.8	7.3	295
374	41223345	86	38.78	101.52	32.0	12.8	30.5	8.0	13.4	375
375	41223345	141	38.82	101.39	7.5	5.1	13.5	3.0	5.7	250
377	411223345	68	38.76	101.38	10.5	6.1	18.3	.6	8.5	350
378	411223345	19	38.76	101.33	2.3	2.1	7.5	.6	2.7	200
380	213345	136	38.82	101.30	4.5	4.4	11.0	31.3	5.1	240
381	41123345	144	38.84	101.28	1.5	2.0	5.8	2.8	2.6	175
382	41123345	111	38.84	101.30	4.8	3.2	10.8	2.8	5.5	200
384	413345	165	38.82	101.20	4.0	2.6	9.9	23.6	3.9	200
385	413345	60	38.76	101.22	11.5	6.0	17.9	22.8	7.7	350
386	213345	151	38.81	101.16	5.0	4.2	9.9	19.3	4.3	250
387	213345	135	38.80	101.12	4.5	5.7	11.8	15.7	5.1	280
388	213345	119	38.79	101.08	7.0	6.1	13.8	9.3	6.0	250
389	213345	121	38.81	101.06	11.0	6.8	14.4	5.7	6.5	350
391	2145	350	38.75	100.89	3.5	2.9	5.5	4.0	2.9	225

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
392	2145	2	38.74	100.87	5.5	3.0	9.7	6.0	4.2	300
394	21125	168	38.86	100.86	2.3	2.7	10.9	3.1	5.0	325
395	21125	205	38.87	100.84	11.8	5.2	13.8	3.1	5.0	325
397	215	15	38.74	100.81	7.0	6.3	13.1	225.6	4.8	370
398	215	176	38.83	100.81	10.3	6.4	15.8	325.1	6.1	350
399	215	172	38.82	100.75	6.3	5.6	13.2	321.0	5.7	325
400	215	196	38.81	100.72	7.0	5.1	13.3	320.3	5.1	325
401	215	69	38.75	100.76	5.3	4.7	10.0	319.2	4.0	325
402	41125	80	38.69	100.85	13.8	4.9	16.0	8.2	5.5	275
403	41125	39	38.67	100.82	12.8	5.3	14.2	8.2	5.5	250
404	4125	21	38.67	100.76	9.5	4.3	17.8	5.7	7.4	300
406	215	169	38.80	100.69	5.5	3.8	12.5	316.4	5.1	350
407	215	176	38.79	100.64	4.3	3.3	10.2	312.9	4.2	350
408	215	43	38.72	100.66	8.3	6.0	13.0	311.8	5.6	375
409	11125	102	38.64	100.74	6.5	3.2	12.0	14.3	5.0	150
410	11125	46	38.57	100.78	68.0	7.2	33.6	14.3	12.4	205
411	4125	93	38.67	100.71	6.3	5.1	12.3	15.2	5.2	225
412	4125	11	38.62	100.63	31.0	7.2	31.9	9.9	14.0	400
414	215	27	38.71	100.54	7.0	5.7	12.0	304.4	5.2	300
415	41125	25	38.64	100.54	29.0	10.3	24.2	4.8	10.1	400
416	41125	346	38.66	100.50	7.0	4.6	15.8	4.8	6.8	350
418	415	2	38.67	100.46	24.0	8.2	26.7	300.0	11.6	425
419	4112235	112	38.91	100.82	49.0	25.4	40.9	18.3	18.6	400
420	4112235	157	38.90	100.70	11.0	5.8	16.0	18.3	6.6	225
421	212235	92	38.85	100.69	14.5	10.0	20.9	13.9	9.0	325
422	212235	105	38.81	100.60	1.3	1.1	9.1	5.7	4.0	275
424	4112235	153	38.86	100.54	2.8	4.0	9.9	5.4	4.3	225
425	4112235	0	38.87	100.52	12.0	6.8	17.8	5.4	6.9	325
427	2135	173	38.81	100.47	14.8	9.0	20.2	1.1	9.2	300
429	415	17	38.67	100.39	17.8	8.8	22.5	294.4	9.9	325
430	415	17	38.68	100.34	11.3	9.3	29.8	291.2	7.8	325
431	41125	26	38.66	100.28	10.3	5.3	13.8	6.4	5.3	250
432	41125	328	38.67	100.25	5.0	2.6	9.7	6.4	4.1	225
433	4125	328	38.71	100.24	6.3	6.7	12.7	.2	5.6	225
435	4112235	123	38.87	100.45	17.8	11.0	23.4	7.2	9.9	350
436	4112235	153	38.89	100.43	11.0	8.8	18.3	7.2	7.4	250
437	412235	178	38.88	100.39	7.8	4.8	14.1	5.8	5.3	175
439	2112235	126	38.82	100.38	2.5	3.8	8.3	2.4	3.8	125
440	2112235	83	38.79	100.40	12.5	5.1	14.9	2.4	6.0	175
442	4135	154	38.84	100.30	23.3	10.2	21.8	.9	9.1	300
444	415	176	38.82	100.27	4.3	4.3	14.8	284.5	6.9	250
445	415	13	38.72	100.22	9.0	7.5	13.7	281.0	6.5	325
446	415	150	38.82	100.24	8.0	7.8	16.3	280.3	7.3	250
447	215	166	38.82	100.22	7.5	5.8	14.8	279.8	6.2	250
448	41125	25	38.73	100.19	8.0	5.5	14.4	.4	6.5	300
449	41125	357	38.71	100.16	10.8	8.7	17.2	.4	7.0	300

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
451	215	153	38.81	100.15	9.0	6.8	14.2	274.9	6.0	300
452	215	358	38.75	100.13	3.8	5.2	11.4	274.2	5.1	250
453	415	355	38.68	100.10	45.0	19.5	37.1	273.2	13.1	400
454	215	356	38.77	100.05	5.0	5.3	12.8	269.7	5.1	250
455	111223345	101	39.11	101.34	8.5	3.9	13.8	19.2	5.9	125
456	111223345	126	39.13	101.31	7.0	4.5	12.4	19.2	5.7	125
457	11223345	158	39.12	101.28	2.5	2.3	7.9	17.6	3.2	75
458	11223345	76	39.07	101.29	12.0	5.4	15.1	15.3	6.0	100
459	11223345	163	39.10	101.20	2.5	2.2	8.1	12.1	3.7	125
460	11223345	10	39.06	101.19	3.3	2.1	8.0	10.9	3.1	125
461	11223345	178	39.10	101.18	2.3	2.2	7.4	9.1	2.7	100
462	11223345	176	39.09	101.16	3.3	3.0	8.2	5.4	3.3	100
463	11223345	150	39.09	101.14	2.8	3.1	8.4	2.0	4.0	100
464	11223345	122	39.08	101.10	1.5	1.1	5.7	11.8	2.0	100
465	11223345	22	39.05	101.14	1.0	1.0	4.9	7.4	1.9	75
466	11223345	4	39.05	101.06	.8	.8	3.9	.6	1.3	50
468	111223345	109	39.12	101.14	10.5	5.9	21.2	3.9	9.8	200
469	111223345	139	39.13	101.11	3.8	.9	9.5	3.9	4.2	125
470	11223345	172	39.12	101.08	.8	.9	4.8	2.8	2.1	50
472	113345	163	39.09	101.03	1.5	1.7	6.5	41.4	3.0	100
473	113345	167	39.08	101.01	3.8	1.8	8.1	39.2	3.8	100
474	113345	86	39.04	101.02	3.5	2.0	16.4	37.0	7.3	180
475	11123345	139	39.06	100.95	2.3	2.8	8.2	.8	3.8	100
476	11123345	171	39.06	100.93	1.0	1.3	5.8	.8	2.5	75
478	113345	169	39.05	100.92	1.5	2.3	6.1	35.0	2.8	100
479	113345	176	39.05	100.91	1.3	2.2	5.2	33.9	2.7	75
480	11123345	155	39.05	100.89	3.3	2.4	6.2	1.2	2.9	75
481	11123345	4	39.04	100.88	1.0	2.4	6.2	1.2	2.2	75
483	113345	174	39.03	100.86	2.8	2.9	7.5	27.5	3.3	100
484	113345	164	39.02	100.83	1.5	1.2	6.7	24.8	3.1	75
485	11123345	105	39.06	100.88	2.3	2.6	6.8	6.0	3.0	75
486	11123345	153	39.07	100.87	1.5	1.3	5.4	6.0	2.0	50
488	113345	150	39.03	100.77	4.0	3.4	10.9	17.2	5.1	175
489	113345	170	39.02	100.75	2.5	2.6	7.4	17.2	3.2	150
490	113345	158	39.02	100.73	3.0	3.4	7.8	14.2	3.5	150
491	113345	149	39.01	100.69	3.0	3.4	8.9	9.4	4.0	200
492	113345	150	39.00	100.66	2.5	2.8	7.1	6.2	3.2	200
493	113345	153	39.00	100.64	3.3	3.5	8.9	5.1	3.5	225
495	111223345	100	39.12	100.98	12.0	5.8	15.1	11.3	7.1	150
496	111223345	154	39.12	100.94	1.5	1.3	6.0	11.3	2.6	75
497	11223345	157	39.12	100.92	.8	1.5	5.1	10.0	2.0	75
498	11223345	171	39.11	100.87	1.3	1.3	15.5	6.9	2.3	50
499	11223345	94	39.08	100.91	6.8	3.2	5.8	5.4	6.8	125
501	111223345	130	39.11	100.83	2.8	2.9	7.8	2.4	3.2	75
502	111223345	192	39.11	100.81	.8	1.2	4.3	2.4	1.8	75

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
503	11223345	113	39.09	100.83	1.5	2.6	9.2	1.1	4.0	100
505	113345	169	39.10	100.79	1.8	1.3	7.2	24.1	3.3	150
506	113345	148	39.10	100.77	2.0	2.3	7.9	21.8	3.6	150
507	113345	160	39.09	100.75	1.3	2.0	5.7	20.7	2.3	125
508	113345	164	39.09	100.74	1.5	1.9	6.8	19.6	2.8	125
509	173	39.08		100.71	1.5	1.4	6.3	18.2	2.9	125
510	113345	186	39.07	100.68	1.8	2.6	7.2	14.8	2.9	75
511	113345	103	39.04	100.72	7.5	6.3	14.7	11.7	6.2	200
512	11123345	156	39.07	100.67	1.5	1.4	5.2	1.7	2.0	100
513	11123345	184	39.07	100.66	1.0	1.4	4.1	1.7	1.8	100
515	113345	175	39.05	100.65	2.0	2.0	6.8	9.3	3.1	125
516	113345	174	39.05	100.63	2.3	2.8	8.2	7.7	3.9	125
517	113345	168	39.04	100.62	2.3	2.7	7.9	5.7	3.9	125
518	113345	173	39.03	100.60	3.0	2.8	8.3	4.2	3.9	115
519	113345	183	39.03	100.57	4.0	4.1	9.2	3.3	3.8	115
521	111245	165	39.02	100.56	2.5	3.7	9.1	2.9	3.3	75
522	111245	197	39.01	100.55	.8	1.3	3.7	2.9	1.7	75
524	111245	60	39.00	101.01	.8	.8	4.0	38.2	4.3	25
526	111245	124	39.02	101.03	4.0	1.7	10.0	38.2	1.8	50
527	11245	152	39.02	101.00	1.5	1.7	5.2	37.5	2.2	50
528	11245	151	39.02	100.99	1.3	1.4	4.2	36.3	1.9	50
529	11245	161	39.01	100.96	1.0	1.5	4.7	34.5	2.0	50
530	11245	171	39.01	100.95	.8	1.2	4.2	33.5	1.9	50
531	11245	148	39.00	100.90	2.5	3.0	8.8	30.1	3.8	75
533	1145	147	38.99	100.53	3.5	5.2	11.7	54.7	5.3	200
534	111245	145	39.01	100.53	2.5	3.7	8.7	2.0	3.6	125
535	111245	186	39.01	100.51	2.5	2.7	6.1	2.0	2.9	125
537	1145	24	38.93	100.51	4.0	3.6	8.2	52.8	3.2	225
538	1145	167	38.98	100.47	3.5	3.1	8.3	49.7	3.9	225
539	11122345	122	39.05	100.54	12.5	8.8	21.3	6.6	9.7	175
540	11122345	153	39.04	100.48	1.8	2.0	5.9	6.6	2.7	100
541	1122345	166	39.03	100.46	1.5	2.0	6.0	5.3	2.6	100
543	11122345	126	39.01	100.42	2.5	3.2	8.4	1.0	3.9	75
544	11122345	155	39.01	100.41	1.0	1.9	5.7	1.0	4.4	75
546	11345	159	39.01	100.40	1.8	2.3	11.9	8.6	2.4	75
547	1112345	142	39.02	100.39	1.0	2.1	5.8	1.8	2.1	75
548	1112345	186	39.02	100.38	1.8	2.2	5.6	1.8	2.1	75
549	112345	189	39.01	100.37	.5	1.6	3.9	.3	1.9	75
551	11345	206	39.00	100.36	2.3	2.8	7.0	6.4	3.2	150
552	11345	126	39.97	100.41	10.0	7.6	16.9	.2	7.7	275
554	4145	189	38.97	100.31	11.0	6.2	16.8	33.5	6.8	250
555	4145	167	38.95	100.27	5.3	4.8	12.7	28.0	5.3	175
556	4145	155	38.97	100.22	25.8	14.3	28.3	16.3	12.1	375
557	4145	164	38.93	100.15	9.0	7.7	16.3	11.6	7.2	225
558	4145	168	38.92	100.13	6.0	7.1	16.8	10.3	7.2	200
559	411245	150	38.92	100.11	7.8	6.0	16.6	3.6	6.7	175

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
560	411245	175	38.92	100.08	10.3	7.5	15.8	3.6	6.4	175
563	4112235	136	38.92	100.01	6.8	5.7	14.1	6.4	5.7	225
564	4112235	191	38.93	99.98	6.5	4.1	12.2	6.4	4.4	225
565	412235	128	38.86	100.02	8.8	8.3	17.2	.8	7.0	300
567	4112235	185	38.90	99.96	4.5	6.2	15.7	.8	7.0	225
568	4112235	203	38.89	99.94	5.3	5.2	15.0	.8	6.5	225
570	211235	173	38.84	99.94	3.8	6.6	14.1	.2	6.5	250
571	211235	194	38.81	99.92	1.3	2.0	8.2	.2	3.6	150
574	4112235	62	38.67	100.03	11.3	6.1	13.1	7.0	4.5	175
575	4112235	351	38.66	99.99	2.3	2.7	7.4	7.0	3.4	125
576	412235	331	38.68	99.98	1.3	1.9	5.9	6.3	2.6	125
577	212235	338	38.70	99.98	.8	1.0	4.0	4.1	1.6	115
578	412235	93	38.72	100.02	9.8	2.9	12.8	3.3	5.0	225
580	4112235	105	38.68	99.96	1.8	1.5	4.9	7.0	1.7	115
581	4112235	6	38.65	99.95	5.0	3.1	9.2	7.0	2.9	125
582	212235	90	38.69	99.96	1.0	1.8	4.3	5.8	1.6	115
583	212235	267	38.70	99.93	.8	.6	4.0	4.1	1.4	115
584	212235	316	38.71	99.93	1.0	1.6	5.1	1.7	2.0	115
585	212235	281	38.72	99.92	1.3	1.8	5.1	1.1	1.9	105
587	2135	329	38.74	99.93	.8	1.8	4.4	4.1	2.0	125
589	41125	170	38.91	99.94	1.0	2.2	7.2	8.9	3.3	125
590	41125	190	38.91	99.92	3.5	3.0	9.3	8.9	3.9	125
592	21125	0	38.73	99.90	1.0	1.5	4.1	3.1	1.6	150
593	21125	330	38.73	99.89	.5	.8	3.1	3.1	1.2	125
594	2125	37	38.73	99.91	1.3	2.0	5.7	2.8	2.2	150
596	2150	17	38.76	99.87	2.8	3.7	8.6	257.2	3.9	250
597	2150	11	38.74	99.86	7.8	9.3	17.8	256.7	6.4	400
598	21125	137	38.86	99.90	2.0	2.0	6.9	6.0	2.8	125
599	21125	169	38.88	99.89	3.0	3.6	9.7	6.0	4.3	150
600	2125	176	38.83	99.86	1.0	1.2	4.7	3.0	2.0	75
602	4150	4	38.75	99.83	3.0	3.9	9.4	255.0	4.0	250
603	1112235	134	38.92	99.91	1.3	1.7	5.3	7.5	2.3	75
604	1112235	163	38.92	99.90	1.0	1.6	5.0	7.5	2.0	75
605	412235	203	38.89	99.87	.5	1.1	2.9	4.9	1.1	75
607	4112235	154	38.88	99.85	2.5	4.0	9.0	1.6	3.9	200
608	4112235	180	38.88	99.84	1.8	3.2	7.6	1.6	4.4	200
610	4135	185	38.87	99.82	5.5	4.4	11.1	3.2	4.5	225
611	411235	174	38.87	99.81	1.3	1.5	5.2	3.0	2.0	125
612	411235	218	38.86	99.79	1.0	1.4	4.2	3.0	1.8	125
613	41235	202	38.84	99.80	1.0	1.5	4.4	1.4	2.0	125
614	41235	173	38.84	99.81	1.0	2.5	7.6	1.1	3.5	175
617	2150	27	38.75	99.81	2.8	2.6	7.5	251.5	3.3	175
618	2150	172	38.82	99.79	1.8	1.3	7.9	250.0	3.8	175
619	1112235	79	38.68	99.91	10.0	6.2	16.1	8.3	6.2	150
620	1112235	32	38.66	99.88	7.0	4.7	11.1	8.3	4.2	150

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
621	112235	146	38.70	99.86	.8	2.2	4.9	7.2	1.7	75
622	412235	357	38.68	99.81	3.0	2.8	7.6	4.1	3.0	150
623	112235	110	38.71	99.83	1.0	1.4	4.0	3.2	1.5	125
625	4112235	79	38.69	99.79	.8	.7	2.9	2.0	1.1	150
626	4112235	353	38.67	99.77	5.8	3.0	9.6	2.0	3.2	175
628	411235	0	38.69	99.75	2.0	2.0	6.1	2.0	2.1	125
629	411235	295	38.70	99.74	2.3	.8	5.3	2.0	2.0	125
631	2135	156	38.86	99.79	1.0	1.7	4.1	1.8	1.6	125
633	41125	156	38.86	99.78	2.3	3.2	7.2	2.3	3.1	225
634	41125	175	38.85	99.77	2.8	2.8	7.4	2.3	2.8	225
636	41125	32	38.73	99.72	2.3	2.7	8.3	3.4	3.3	225
637	41125	343	38.72	99.70	6.8	3.9	10.6	3.4	4.1	225
639	41125	147	38.86	99.73	3.0	4.0	9.2	3.4	3.5	225
640	41125	184	38.87	99.71	2.3	2.5	6.9	3.4	3.0	175
642	41125	149	38.87	99.69	2.8	2.1	7.8	4.6	3.0	175
643	41125	190	38.88	99.67	6.0	3.9	9.1	4.6	3.4	175
645	215	18	38.87	99.67	1.8	4.2	8.6	237.8	3.8	350
646	215	169	38.81	99.66	1.0	2.2	6.9	236.9	2.9	225
647	215	17	38.78	99.66	1.3	3.3	6.9	236.7	3.1	275
648	21125	177	38.85	99.65	5.8	6.1	12.3	1.8	5.7	250
649	21125	199	38.84	99.63	4.0	2.6	11.2	1.8	4.8	250
651	215	11	38.77	99.65	1.3	1.8	5.5	235.8	2.1	200
652	2112235	56	38.74	99.67	.8	1.1	2.5	3.9	1.2	175
653	4112235	23	38.72	99.67	2.5	1.6	6.5	3.9	3.6	175
654	412235	15	38.73	99.65	4.8	2.9	7.1	2.1	3.0	250
656	4112235	43	38.72	99.63	2.5	2.0	5.4	1.7	2.1	135
657	4112235	344	38.72	99.61	1.8	1.6	3.5	1.7	1.9	130
660	215	173	38.82	99.61	3.8	2.8	9.9	233.1	4.2	250
661	215	176	38.81	99.60	1.5	2.1	6.8	232.8	3.1	250
662	215	23	38.76	99.61	1.5	2.4	7.9	232.8	3.3	300
6632	2112235	45	38.72	99.59	1.0	1.0	4.1	1.4	1.8	250
664	2112235	352	38.71	99.58	1.5	1.8	4.8	1.4	1.8	200
666	2112235	351	38.71	99.56	1.0	1.2	3.9	1.7	1.4	125
667	2112235	280	38.72	99.56	.8	1.0	2.9	1.7	1.2	125
669	2135	75	38.76	99.59	1.5	2.4	6.2	.8	2.5	250
671	215	37	38.75	99.55	.8	2.0	5.1	229.2	2.1	200
672	215	8	38.73	99.54	2.5	2.8	7.0	228.9	2.7	300
673	21125	120	38.85	99.62	2.5	3.9	8.7	10.0	4.0	165
674	21125	160	38.86	99.61	3.3	3.2	8.2	10.0	3.2	125
675	2125	172	38.86	99.59	4.5	4.6	9.6	8.1	4.0	150
676	2125	208	38.84	99.55	3.3	4.0	9.8	6.1	4.1	225
678	21125	150	38.85	99.52	5.8	4.3	10.5	4.6	4.4	200
679	21125	194	38.84	99.50	6.3	3.8	10.8	4.6	4.0	150
680	2125	152	38.81	99.53	2.0	2.0	7.0	2.8	3.1	200
681	2125	203	38.80	99.50	1.3	1.8	5.0	2.3	1.9	125

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
683	215	26	38.75	99.52	.8	1.6	4.3	227.0	1.9	125
684	215	23	38.74	99.51	1.5	2.0	6.1	226.4	2.8	150
685	21125	74	38.72	99.53	1.0	1.4	5.0	2.0	2.2	200
686	21125	35	38.71	99.52	3.0	3.4	9.0	2.0	3.0	210
688	215	31	38.72	99.88	4.5	5.1	10.2	223.4	4.1	200
689	2112235	166	38.80	99.48	1.3	2.2	6.7	2.1	2.7	175
690	2112235	196	38.80	99.47	1.3	2.1	5.9	2.1	2.7	175
691	212235	157	38.79	99.49	3.0	4.1	9.2	.7	3.8	200
693	2112235	180	38.79	99.46	1.8	3.9	9.3	1.1	3.7	175
694	2112235	200	38.78	99.45	1.0	2.2	6.4	1.1	2.8	125
697	215	165	38.76	99.45	1.8	3.0	6.7	222.3	3.1	150
698	215	184	38.77	99.44	4.8	6.7	13.0	222.0	6.0	275
699	21125	156	38.76	99.42	4.5	5.0	13.2	.4	5.6	150
700	21125	193	38.76	99.39	4.5	3.4	9.4	.4	4.0	150
702	215	51	38.72	99.45	1.3	2.3	5.6	221.3	2.2	125
703	21125	125	38.69	99.52	1.5	1.2	4.1	7.8	1.5	75
704	21125	89	38.69	99.53	2.8	4.3	9.0	7.8	3.6	150
705	2125	63	38.67	99.52	4.3	5.5	10.9	7.1	4.2	160
706	2125	29	38.68	99.48	2.3	2.8	6.6	5.2	2.2	100
707	2125	5	38.68	99.46	1.0	1.4	4.2	4.1	1.7	75
709	21125	62	38.69	99.43	2.0	2.9	6.5	3.2	2.7	100
710	21125	39	38.69	99.42	.3	1.2	2.5	3.2	1.3	60
711	2125	25	38.68	99.42	1.6	1.4	5.6	3.0	2.1	100
713	215	40	38.69	99.36	2.3	2.1	6.5	215.8	2.2	140
714	2112235	142	38.83	99.39	1.3	2.8	6.4	5.0	2.5	125
715	2112235	168	38.83	99.38	1.0	1.9	4.3	5.0	2.2	125
716	212235	142	38.82	99.40	2.5	3.4	10.1	3.8	4.7	200
718	2112235	164	38.80	99.35	2.3	3.1	8.7	.7	3.5	100
719	2112235	222	38.79	99.33	2.3	2.7	5.4	.7	2.2	100
721	211235	119	38.84	99.47	6.0	4.9	12.8	7.2	5.3	150
722	211235	164	38.84	99.44	3.8	2.8	7.5	7.2	2.8	130
723	21235	77	38.77	99.38	.8	1.2	3.5	3.0	1.1	80
725	2135	127	38.74	99.36	.8	1.1	3.6	2.4	1.7	80
726	211235	134	38.74	99.38	1.8	2.5	6.0	.8	2.5	90
727	211235	180	38.73	99.36	.5	2.3	2.9	.8	1.2	90
730	11223345	89	38.65	99.72	1.8	2.5	6.1	2.1	2.7	90
731	411223345	133	38.66	99.72	2.5	2.9	8.0	2.1	3.0	100
733	411223345	153	38.68	99.70	6.3	4.5	10.8	1.2	4.5	110
734	411223345	171	38.65	99.68	1.5	1.7	5.5	1.2	2.5	100
736	41123345	129	38.64	99.64	4.5	6.2	15.0	.3	7.0	250
737	21123345	143	38.63	99.62	3.5	4.1	10.5	.3	4.8	200
739	413345	158	38.66	99.62	10.5	9.0	19.0	9.9	8.0	250
740	21123345	126	38.60	99.64	6.8	4.2	14.1	2.3	6.5	200
741	21123345	74	38.57	99.62	2.5	2.0	7.8	2.3	3.1	75
742	2123345	348	38.56	99.60	1.3	.7	3.5	2.1	1.3	60

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
743	2123345	352	38.57	99.59	.5	.9	3.1	1.2	1.3	50
744	2123345	18	38.56	99.57	2.0	2.2	6.9	.4	2.2	85
746	213345	0	38.56	99.55	2.5	2.2	6.1	6.0	2.1	75
747	213345	338	38.57	99.48	1.8	1.9	5.4	1.2	2.1	100
749	411223345	120	38.70	99.61	8.0	8.1	15.3	3.0	6.3	225
750	411223345	172	38.69	99.57	1.5	2.2	5.0	3.0	2.0	150
752	211223345	137	38.66	99.60	1.0	1.2	4.8	1.7	2.1	150
753	211223345	170	38.67	99.59	1.3	2.0	4.9	1.7	2.1	150
755	213345	122	38.63	99.58	8.5	7.2	17.1	4.0	7.6	250
756	213345	134	38.64	99.53	5.8	7.7	13.6	1.0	6.2	125
758	21450	336	38.58	99.46	2.0	2.6	6.8	21.7	2.8	125
759	211245	119	38.64	99.51	2.8	3.0	8.1	2.8	3.4	125
760	211245	164	38.65	99.49	4.3	3.2	7.8	2.8	3.1	125
762	2145	7	38.59	99.45	2.3	3.2	7.3	18.9	3.2	200
763	2145	122	38.64	99.46	4.5	4.1	9.3	17.8	4.1	110
764	211245	10	38.57	99.44	1.0	1.2	3.4	2.9	1.2	100
765	211245	341	38.57	99.43	1.0	1.1	3.6	2.9	1.5	100
766	21245	339	38.59	99.42	1.8	2.1	5.5	1.4	2.1	125
767	21245	330	38.60	99.42	.8	.9	4.6	1.0	2.0	150
769	2145	137	38.65	99.44	2.0	3.3	8.2	15.5	3.3	75
770	2145	164	38.65	99.42	2.8	2.0	6.9	15.3	2.9	75
771	2145	29	38.61	99.41	3.3	4.3	8.6	14.0	3.7	170
772	2145	16	38.60	99.39	2.5	3.2	8.0	13.6	3.4	170
773	2145	6	38.61	99.37	1.5	2.9	7.0	12.6	3.1	125
774	211245	23	38.59	99.36	1.3	2.3	5.5	1.0	2.2	100
775	211245	343	38.59	99.35	3.3	2.2	7.0	1.0	2.6	90
777	2145	160	38.62	99.31	5.5	4.1	11.6	8.5	4.2	125
779	215	185	38.74	99.33	1.3	2.1	5.7	213.8	2.4	125
780	215	180	38.73	99.32	1.0	1.8	5.1	212.8	2.4	105
781	215	160	38.75	99.30	6.0	4.7	11.6	210.9	5.0	120
782	215	44	38.67	99.28	6.3	5.3	11.1	207.9	4.5	170
783	21125	71	38.62	99.28	1.5	2.3	6.3	6.2	2.2	150
784	21125	10	38.61	99.27	2.8	2.2	6.8	6.2	2.5	150
785	2125	80	38.64	99.28	1.0	1.5	3.8	5.0	1.5	55
787	215	0	38.64	99.22	17.5	9.4	20.7	204.2	8.3	250
788	215	162	38.73	99.22	1.5	1.5	5.0	201.7	1.8	100
789	215	182	38.74	99.17	1.8	2.3	6.1	194.6	2.2	130
790	515	17	38.68	99.17	7.0	7.9	15.5	193.5	6.9	225
791	515	24	38.67	99.15	4.5	3.9	16.3	190.6	6.9	200
792	21125	31	38.63	99.16	8.5	6.0	12.2	6.0	5.0	120
793	21125	356	38.62	99.13	5.3	5.5	10.5	6.0	4.9	120
794	2125	0	38.66	99.11	3.5	2.5	8.4	3.2	4.0	120
796	51125	166	38.74	99.10	2.5	2.3	6.5	.7	2.5	100
797	51125	212	38.75	99.08	2.5	2.3	7.8	.7	3.2	95

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
799	21125	41	38.58	99.11	5.3	3.2	8.5	9.5	3.7	115
800	21125	3	38.58	99.09	1.8	2.1	5.5	9.5	2.9	115
801	2125	331	38.58	99.07	4.0	3.0	7.5	9.0	3.0	75
803	21125	22	38.61	99.05	2.3	2.1	7.1	8.0	2.7	65
804	21125	331	38.62	99.03	2.5	2.6	4.9	8.0	2.3	70
806	21125	358	38.68	99.01	2.0	2.7	6.0	2.5	3.0	110
807	21125	315	38.69	98.97	3.8	1.8	8.5	2.5	4.0	60
809	51125	119	38.77	99.02	2.0	2.5	6.5	1.3	2.2	140
810	51125	164	38.77	99.01	1.5	2.4	6.0	1.3	2.1	150
812	51125	123	38.77	98.99	.5	1.8	4.4	1.2	1.8	125
813	51125	171	38.78	98.97	2.3	1.9	5.8	1.2	2.0	125
815	315	337	38.74	98.92	1.8	1.7	5.1	175.5	2.2	180
816	31125	16	38.76	98.90	1.8	2.1	5.5	.2	2.0	125
817	31125	330	38.77	98.89	.5	.7	2.1	.2	1.1	50
819	11123345	112	39.11	100.73	6.0	6.3	14.0	21.2	6.3	90
820	11123345	89	39.10	100.70	2.3	1.9	6.2	21.2	2.8	50
821	11223345	155	39.10	100.64	2.8	1.4	7.1	18.3	2.3	20
822	11223345	138	39.13	100.65	9.3	5.0	16.5	16.3	5.6	60
823	11223345	156	39.10	100.60	4.8	2.0	5.5	14.3	3.0	50
824	11223345	148	39.09	100.54	2.5	1.7	6.5	10.2	2.9	50
826	111223345	106	39.10	100.54	9.3	9.5	21.0	6.7	9.9	150
827	111223345	132	39.11	100.50	4.0	3.1	8.5	6.7	4.0	75
828	11223345	169	39.10	100.46	.8	1.6	3.7	5.6	1.8	50
829	11223345	149	39.09	100.45	2.3	3.0	6.5	2.9	3.0	100
831	113345	164	39.08	100.39	4.3	3.2	9.9	78.5	4.3	100
832	113345	156	39.07	100.36	4.8	4.0	11.5	75.3	5.2	100
833	113345	22	39.02	100.35	1.5	2.0	5.0	74.7	1.9	50
834	113345	155	39.06	100.34	3.3	3.2	10.4	72.9	5.0	100
835	113345	162	39.06	100.32	4.5	3.5	9.5	71.6	4.0	100
836	113345	153	39.05	100.29	2.5	3.3	9.0	69.2	4.2	100
837	113345	9	39.01	100.26	1.0	1.5	3.5	67.3	1.5	50
838	113345	142	39.04	100.27	2.5	3.2	8.0	66.3	4.0	125
839	11123345	91	39.09	100.36	3.5	2.8	9.0	10.6	3.4	75
840	11123345	132	39.11	100.34	2.5	1.9	6.0	10.6	2.6	75
841	1123345	106	39.07	100.29	1.3	2.3	6.5	4.4	2.9	75
842	1123345	162	39.04	100.24	1.3	1.5	4.3	.9	2.3	75
844	113345	156	39.05	100.22	4.8	2.9	8.0	62.3	3.5	150
845	113345	97	39.00	100.22	5.8	4.5	9.5	60.1	4.0	125
846	11123345	152	39.04	100.18	4.0	3.6	10.4	2.0	4.2	150
847	11123345	201	39.03	100.15	1.8	1.9	5.2	2.0	2.0	125
849	113345	164	39.01	100.09	3.5	3.2	8.1	55.7	3.3	125
850	11123345	128	39.02	100.11	2.0	2.5	5.2	2.8	2.2	100
851	11123345	165	39.03	100.09	1.8	2.6	6.4	2.8	2.2	100
853	11123345	128	39.02	100.07	2.8	3.0	8.1	2.2	3.2	125
854	11123345	160	39.02	100.05	1.3	1.6	5.3	2.2	2.2	75
855	1123345	178	39.02	100.04	2.0	1.7	6.1	1.6	2.6	75

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
857	113345	135	39.01	99.99	8.8	6.8	13.3	37.0	5.9	150
858	113345	0	38.96	99.96	2.0	3.1	7.6	36.1	3.0	110
859	11123345	139	39.03	99.97	3.8	4.1	10.6	1.9	4.3	85
860	11123345	171	39.02	99.95	1.3	2.1	5.4	1.9	2.3	75
862	113345	158	39.01	99.93	2.5	2.8	8.7	31.9	3.8	110
863	113345	21	38.96	99.92	2.8	3.3	9.9	31.4	3.7	120
864	113345	172	39.01	99.90	1.5	2.8	7.1	30.2	3.0	75
865	113345	78	38.97	99.90	3.5	4.9	9.0	28.2	3.2	150
866	113345	159	39.00	99.88	4.0	2.4	9.2	26.7	3.7	125
867	113345	37	38.95	99.88	5.0	5.3	9.2	26.0	4.0	150
868	413345	176	38.99	99.84	2.8	2.2	7.5	24.7	3.2	120
869	11123345	92	38.93	99.87	1.5	1.9	4.3	4.1	2.1	80
870	11123345	354	38.91	99.86	1.8	.9	5.5	4.1	1.9	80
871	1123345	354	38.91	99.85	2.0	2.2	5.0	2.9	2.1	60
873	113345	28	38.92	99.82	3.8	3.8	8.3	21.5	3.2	160
874	413345	170	38.98	99.81	3.8	4.1	10.5	20.5	4.2	130
875	413345	182	38.96	99.79	2.0	2.8	6.4	19.8	3.3	130
876	213345	183	38.95	99.78	1.0	1.6	4.2	18.4	1.9	125
877	113345	62	38.90	99.79	6.3	4.3	10.3	15.9	3.2	200
878	113345	32	38.89	99.76	2.5	2.2	6.2	14.0	3.0	150
879	113345	0	38.89	99.73	.8	1.0	1.9	12.8	1.2	100
880	113345	335	38.90	99.71	1.0	1.3	4.2	10.3	1.8	110
881	41123345	121	38.97	99.78	.8	1.2	3.5	5.7	2.0	85
882	41123345	156	38.98	99.78	1.5	2.2	6.5	5.7	2.8	75
884	113345	342	38.90	99.70	.0	1.9	4.3	9.2	1.9	120
885	4113345	134	38.97	99.75	2.8	3.8	7.8	3.7	3.6	125
886	41123345	164	38.97	99.73	5.8	2.1	7.4	3.7	2.9	125
887	4123345	162	38.95	99.71	2.8	2.3	7.0	1.4	3.5	125
889	213345	154	38.94	99.69	1.3	2.2	5.5	6.7	2.9	125
890	213345	106	38.94	99.67	2.5	3.0	7.1	3.2	2.9	125
891	213345	16	38.91	99.64	1.8	2.7	6.8	1.6	3.2	200
892	213345	358	38.90	99.61	5.3	4.1	10.2	.4	4.2	210
894	111223345	106	39.02	99.80	10.5	5.5	17.3	15.3	6.7	125
895	111223345	163	39.03	99.78	2.0	2.3	5.0	15.3	2.3	75
896	11223345	163	39.02	99.74	1.3	1.4	4.5	12.1	1.9	75
897	11223345	156	39.02	99.71	3.0	3.2	8.3	8.2	3.2	100
898	11223345	166	39.02	99.69	3.3	4.2	8.1	6.2	4.0	110
899	11223345	180	39.00	99.67	3.0	3.0	8.0	5.1	3.8	115
900	41223345	112	38.97	99.69	2.5	2.4	8.2	3.5	3.5	110
902	411223345	162	39.00	99.65	2.3	3.1	8.4	1.9	3.8	175
903	411223345	187	39.00	99.63	2.8	3.0	7.4	1.9	3.2	175
906	4145	14	38.91	99.58	2.5	3.3	7.4	62.2	3.3	175
907	411245	115	39.00	99.62	1.0	1.1	5.0	6.1	2.3	75

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
908	411245	170	39.01	99.61	2.5	1.9	5.4	6.1	2.2	75
910	411245	155	39.00	99.59	2.5	2.0	6.1	3.1	3.1	125
911	411245	198	39.00	99.56	3.8	2.3	6.4	3.1	3.3	115
913	4145	24	38.91	99.56	2.5	1.9	6.4	58.2	3.1	160
914	211245	157	39.00	99.54	.8	1.2	2.1	4.6	1.3	60
915	211245	202	39.00	99.53	1.0	1.7	2.5	4.6	1.3	60
916	21245	180	38.98	99.55	1.5	2.2	5.2	2.4	2.8	160
918	2145	174	38.97	99.51	5.8	6.8	11.2	54.0	5.4	175
919	4145	52	38.89	99.53	10.5	10.2	16.2	52.5	6.2	275
920	2145	29	38.89	99.48	5.3	3.7	8.1	51.0	3.3	225
921	2145	174	38.90	99.46	1.8	1.9	5.5	50.9	2.8	210
922	2145	159	38.97	99.48	10.3	5.2	14.2	49.8	6.7	225
923	21122345	146	39.00	99.46	1.3	1.5	5.2	2.7	2.1	100
924	21122345	180	39.00	99.45	1.3	1.5	4.3	2.7	2.2	100
926	21122345	171	38.99	99.43	2.0	1.7	8.3	1.6	3.9	150
927	21122345	197	38.98	99.42	3.0	3.0	7.8	1.6	3.7	150
930	211245	13	38.87	99.42	2.0	3.4	7.5	2.0	3.0	150
931	211245	260	38.88	99.41	.8	.6	1.7	2.0	1.1	100
932	21245	90	38.88	99.43	1.3	1.2	3.6	1.8	1.3	150
933	21245	82	38.90	99.42	1.0	.6	2.5	.8	1.0	110
935	211245	149	38.98	99.40	1.0	1.6	3.6	4.2	1.9	100
936	211245	182	38.99	99.39	1.5	1.7	5.4	4.2	2.2	100
937	21245	174	38.96	99.40	1.3	2.1	4.5	2.3	2.4	110
939	2145	192	38.94	99.38	3.0	1.7	8.9	45.2	4.4	175
940	2145	194	38.92	99.37	2.0	1.9	5.4	44.1	2.2	110
941	211245	154	38.93	99.36	2.0	1.4	4.5	2.1	2.2	150
942	211245	198	38.93	99.34	2.8	2.6	6.9	2.1	3.1	160
944	2145	75	38.87	99.38	2.3	2.5	6.5	41.7	3.2	225
945	2145	64	38.85	99.37	2.5	3.1	6.5	40.2	2.8	210
946	211245	165	38.93	99.33	2.0	.8	5.5	4.5	2.8	115
947	211245	195	38.93	99.31	1.8	1.1	5.5	4.5	2.1	100
949	211245	175	38.91	99.30	2.0	1.6	6.1	5.7	2.9	125
950	211245	204	38.90	99.29	.8	1.6	3.0	5.7	1.8	110
951	21245	186	38.88	99.29	3.3	4.3	10.0	1.9	4.9	175
953	211245	123	38.84	99.34	2.8	4.2	8.8	2.0	4.0	160
954	211245	108	38.82	99.34	4.8	1.8	9.5	2.0	4.0	125
956	211245	148	38.89	99.27	1.3	1.6	4.3	6.1	1.9	135
957	211245	169	38.90	99.26	3.5	4.8	8.9	6.1	4.2	150
959	2145	184	38.81	99.24	1.3	1.9	5.8	29.0	2.3	50
960	2145	180	38.81	99.22	5.0	3.4	12.2	27.1	6.2	75
961	211245	137	38.79	99.30	1.8	2.2	6.2	5.7	3.0	75
962	211245	90	38.78	99.30	2.0	2.6	6.4	5.7	2.3	75
963	21245	16	38.75	99.26	1.3	1.2	4.2	3.5	1.5	60
964	21245	358	38.75	99.23	.8	1.2	2.5	2.0	1.3	50
966	2145	9	38.75	99.21	1.5	1.6	3.9	26.0	1.9	50

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
967	2145	357	38.75	99.20	1.0	1.1	2.6	25.5	1.6	50
968	2145	345	38.75	99.17	.8	1.0	3.4	23.0	1.2	50
969	211245	130	38.80	99.20	5.0	3.0	11.2	1.4	5.6	110
970	211245	172	38.81	99.18	4.5	3.0	9.4	1.4	4.4	110
972	2145	164	38.79	99.15	1.3	1.9	5.3	20.7	2.8	70
973	21122345	112	38.97	99.35	10.0	6.8	14.1	2.1	6.8	150
974	21122345	158	38.99	99.32	5.5	4.2	10.9	2.1	4.0	110
976	21122345	125	38.99	99.31	1.0	1.3	4.6	2.2	2.3	100
977	21122345	169	39.00	99.29	3.5	2.3	7.2	2.2	3.1	110
979	2112345	164	38.99	99.26	5.5	3.8	9.9	3.6	4.5	125
980	2112345	194	38.97	99.24	1.5	1.1	4.2	3.6	2.2	110
981	212345	197	38.96	99.24	1.0	1.8	4.3	1.7	2.1	75
982	212345	142	38.96	99.26	1.0	3.2	7.5	1.1	3.1	125
984	21345	177	38.97	99.22	7.0	7.2	15.4	12.3	7.3	175
985	21345	112	38.89	99.24	2.5	1.9	7.5	9.8	3.1	200
986	2112345	174	38.96	99.20	6.8	7.9	14.4	5.8	6.2	150
987	2112345	195	38.95	99.19	1.8	3.6	7.5	5.8	3.9	125
989	2112345	146	38.92	99.16	7.8	6.8	15.3	4.7	6.9	175
990	2112345	166	38.93	99.15	7.8	9.6	18.3	4.7	8.9	225
993	2145	15	38.78	99.08	1.5	2.1	5.9	14.8	2.5	100
994	2145	0	38.79	99.06	.8	1.2	2.3	13.5	1.1	100
995	211245	163	38.85	99.08	1.5	2.1	6.5	1.5	2.3	55
996	211245	193	38.85	99.07	1.0	1.8	4.1	1.5	2.0	50
997	21245	138	38.84	99.08	3.0	3.4	8.2	3.0	4.1	75
999	21122345	135	38.99	99.18	1.8	2.1	8.4	3.1	3.2	65
1000	21122345	162	38.99	99.17	1.0	1.7	3.8	3.1	1.9	50
1001	21122345	194	38.99	99.16	.8	.6	4.3	3.1	1.2	45
1003	21122345	156	38.99	99.15	1.3	1.3	4.1	3.0	2.0	75
1004	21122345	212	38.99	99.13	.5	1.0	3.1	3.0	1.0	75
1005	2122345	215	38.98	99.13	.8	1.5	3.9	2.2	1.0	75
1007	21345	170	38.95	99.13	1.5	2.9	5.9	17.8	2.8	100
1008	2112345	148	38.95	99.12	1.8	3.4	7.2	1.6	3.4	125
1009	2112345	178	38.96	99.11	2.5	2.7	6.1	1.6	2.6	125
1010	212345	186	38.95	99.09	1.5	2.9	7.9	.8	3.9	150
1012	21345	180	38.94	99.08	2.8	3.9	8.1	14.5	3.8	175
1013	21345	190	38.90	99.05	1.8	2.3	5.5	10.5	2.6	75
1014	21345	167	38.88	99.03	4.3	4.1	9.2	5.5	4.1	120
1016	211245	152	38.86	98.00	3.3	4.3	9.2	1.5	4.1	110
1017	211245	171	38.86	98.98	1.8	3.2	7.0	1.5	3.4	110
1018	21245	180	38.85	98.96	3.0	3.5	8.1	.5	3.5	160
1020	511245	167	38.84	98.94	3.3	3.4	8.2	1.1	3.4	110

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1021	511245	213	38.84	98.91	3.0	2.5	7.5	1.1	2.8	110
1024	515	170	38.82	98.90	1.8	3.8	8.0	170.0	3.8	175
1025	515	173	38.82	98.89	2.5	2.5	8.9	169.2	3.2	175
1026	51125	178	38.81	98.87	.8	1.0	5.2	.8	2.6	150
1027	51125	209	38.80	98.86	.5	1.0	4.2	.8	1.8	130
1029	21125	61	38.66	98.94	9.0	5.5	13.0	11.4	5.1	125
1030	21125	0	38.65	98.91	6.0	4.9	9.5	11.4	4.6	125
1031	2125	338	38.66	98.89	4.3	2.9	9.3	10.6	4.7	125
1032	2125	323	38.69	98.89	1.3	1.5	6.0	10.7	2.8	100
1033	2125	69	38.70	98.95	11.0	8.7	16.8	8.2	7.5	160
1034	2125	357	38.70	98.87	8.5	5.0	16.5	6.2	7.2	160
1035	5125	88	38.74	98.89	2.5	2.5	6.4	4.0	2.4	120
1036	2125	338	38.74	98.84	2.8	2.4	7.1	2.8	2.9	200
1037	5125	342	38.75	98.83	1.5	2.2	5.5	.8	4.1	175
1039	2112235	99	38.87	98.88	12.3	6.8	17.9	166.0	6.9	100
1040	2112235	12	38.84	98.85	1.5	2.3	5.5	7.2	2.2	75
1041	212235	179	38.89	98.82	7.3	5.0	11.1	5.4	4.8	85
1042	212235	104	38.84	98.84	1.3	1.5	3.8	3.5	1.8	110
1044	2112235	186	38.85	98.80	1.8	2.2	5.7	5.0	2.8	75
1045	2112235	220	38.85	98.78	1.8	1.3	5.1	5.0	2.1	75
1047	5135	115	38.81	98.83	3.5	3.2	10.3	1.1	4.0	150
1049	2112235	44	38.62	98.86	1.3	1.1	5.5	1.1	1.8	50
1050	2112235	6	38.62	98.85	1.0	.9	4.0	1.1	1.9	50
1052	2112235	341	38.62	98.83	2.0	2.0	5.9	1.5	1.9	75
1053	2112235	275	38.63	98.82	2.3	2.3	6.4	1.5	3.0	75
1055	211235	40	38.65	98.82	1.3	1.8	4.1	1.2	1.9	60
1056	211235	330	38.65	98.80	2.8	2.7	7.5	1.2	2.8	75
1058	2135	342	38.68	98.80	1.5	1.2	6.2	9.2	3.0	175
1059	211235	2	38.67	98.79	1.3	1.8	5.8	2.1	2.6	75
1060	211235	333	38.67	98.78	2.0	2.1	5.2	2.1	2.8	75
1061	21235	292	38.70	98.78	1.0	.8	2.2	1.1	1.2	60
1063	5135	345	38.77	98.77	2.3	3.7	7.1	.3	3.1	175
1065	51125	153	38.83	98.76	5.0	4.5	10.9	.2	4.5	165
1066	51125	180	38.83	98.74	2.0	2.8	8.0	.2	3.6	165
1068	21125	36	38.67	98.75	4.5	4.3	10.5	9.5	4.2	125
1069	21125	358	38.66	98.72	5.8	4.9	11.1	9.5	4.6	125
1070	2125	318	38.68	98.71	2.3	1.8	6.1	9.3	2.8	75
1071	2125	330	38.72	98.70	3.8	3.9	8.0	5.5	3.8	125
1072	2125	351	38.75	98.70	1.5	1.9	4.9	3.0	2.8	125
1074	21125	122	38.86	98.72	2.8	2.0	6.2	4.4	2.2	75
1075	21125	187	38.87	98.70	2.0	1.9	4.5	4.4	2.1	75
1076	2125	187	38.85	98.69	1.3	2.0	4.3	3.1	2.1	125
1078	515	182	38.84	98.67	4.8	5.2	10.3	155.0	4.8	225
1079	515	181	38.84	98.66	2.5	3.5	8.1	153.9	4.1	225

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1080	515	179	38.84	98.65	2.5	3.6	8.4	153.0	4.5	225
1081	515	26	38.78	98.66	4.3	4.8	9.5	152.9	4.3	210
1082	2112235	74	38.67	98.70	1.8	2.3	6.2	8.2	2.2	75
1083	2112235	30	38.66	98.69	1.3	1.9	4.3	8.2	1.9	75
1084	212235	348	38.65	98.67	2.3	1.9	5.1	7.8	2.0	75
1085	212235	113	38.70	98.68	.8	1.2	3.6	5.2	2.2	65
1086	212235	145	38.71	98.67	.5	.6	2.3	4.3	1.2	50
1087	212235	347	38.68	98.63	8.0	5.0	15.1	2.5	6.8	175
1088	212235	338	38.72	98.63	.5	1.0	2.3	1.4	1.3	75
1090	2112235	57	38.74	98.67	3.0	2.1	8.1	1.8	3.2	75
1091	2112235	149	38.75	98.66	.5	1.1	2.2	1.8	1.1	60
1092	212235	52	38.74	98.65	.8	1.2	2.5	.7	1.3	75
1094	2135	122	38.76	98.64	1.0	1.7	4.1	5.3	1.7	110
1095	2135	113	38.77	98.64	.8	1.3	2.5	4.2	1.3	110
1097	51125	151	38.87	98.60	1.8	3.0	7.6	4.8	3.0	75
1098	51125	186	38.88	98.58	3.3	2.8	7.5	4.8	2.9	75
1099	5125	154	38.84	98.61	4.8	7.1	12.1	.6	5.9	200
1101	21125	172	38.86	98.57	1.0	2.1	4.1	3.5	2.3	110
1102	21125	189	38.86	98.56	2.8	2.8	7.8	3.5	2.9	110
1103	2125	201	38.85	98.55	1.8	3.1	6.9	2.7	2.9	110
1105	51125	32	38.78	98.55	.8	1.2	2.5	.6	1.3	150
1106	51125	0	38.77	98.54	1.0	2.8	2.8	.6	1.8	150
1108	21125	186	38.86	98.51	.8	1.1	3.2	3.2	1.1	100
1109	21125	225	38.85	98.50	.5	.8	2.5	3.2	1.1	100
1111	515	175	38.83	98.50	3.5	2.6	8.5	138.6	4.3	175
1112	2112235	53	38.64	98.56	1.3	.8	4.0	4.8	1.9	50
1113	2112235	342	38.63	98.55	.8	.8	3.2	4.8	1.1	50
1114	212235	128	38.65	98.56	.5	.8	2.5	3.6	1.2	50
1115	212235	346	38.65	98.54	1.8	2.7	5.9	1.6	3.2	125
1116	212235	317	38.67	98.53	1.8	1.9	6.5	1.3	2.9	150
1118	2112235	96	38.68	98.59	1.5	2.1	5.5	1.8	2.1	115
1119	2112235	32	38.66	98.59	7.3	4.5	10.0	1.8	4.2	150
1121	213	319	38.70	98.53	.8	.9	4.3	9.5	1.9	150
1122	211235	50	38.70	98.60	5.5	3.8	10.9	2.4	4.8	110
1123	211235	323	38.72	98.59	1.8	1.8	4.0	2.4	2.7	75
1125	211235	91	38.75	98.57	3.5	3.2	8.5	1.2	3.2	125
1126	211235	153	38.76	98.55	1.3	2.0	5.0	1.2	2.0	125
1129	51125	132	38.85	98.47	.5	1.2	3.5	5.2	1.2	75
1130	51125	187	38.85	98.46	1.0	.8	2.9	5.2	1.4	75
1131	5125	185	38.80	98.45	.5	.9	1.4	.3	.7	60
1133	51125	184	38.83	98.44	2.5	3.2	11.1	1.0	3.3	200
1134	51125	206	38.82	98.42	2.0	2.2	7.1	1.0	2.8	200
1136	21125	100	38.74	98.49	.5	.5	1.3	5.6	.9	60
1137	21125	49	38.74	98.49	.5	.8	2.1	5.6	1.0	60

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1139	21125	42	38.66	98.51	2.0	2.8	6.4	10.4	2.9	125
1140	21125	4	38.66	98.50	2.3	1.6	5.0	10.4	2.2	75
1141	2125	317	38.67	98.48	1.5	1.0	4.1	9.9	2.0	125
1142	5125	337	38.76	98.42	.5	1.2	1.8	1.9	1.4	160
1144	3112235	216	38.89	98.34	2.0	1.9	6.5	4.7	2.2	100
1145	3112235	265	38.87	98.34	1.0	1.2	3.5	4.7	1.6	100
1146	312235	250	38.86	98.34	1.3	1.7	4.3	3.2	1.9	115
1147	312235	222	38.83	98.35	.8	1.2	3.9	.8	1.7	85
1149	3112235	125	38.87	98.40	1.3	1.2	6.2	3.5	2.4	75
1150	3112235	174	38.87	98.39	1.0	1.9	3.1	3.5	18.	75
1151	312235	61	38.85	98.40	1.8	2.1	3.8	3.0	1.1	110
1152	312235	219	38.87	98.37	3.3	3.2	7.1	3.0	3.1	75
1153	312235	94	38.84	98.39	1.8	1.9	4.2	1.9	2.2	110
1154	312235	95	38.83	98.39	1.0	2.1	5.1	.9	2.4	125
1156	311235	183	38.83	98.34	1.3	1.4	5.1	7.9	2.1	75
1157	311235	227	38.82	98.33	1.0	1.2	3.9	7.9	1.1	75
1160	2112235	41	38.67	98.45	.8	1.4	3.1	1.0	1.8	110
1161	2112235	0	38.67	98.44	.5	.9	4.2	1.0	1.3	110
1163	2112235	358	38.67	98.42	1.5	1.2	3.1	.4	1.7	125
1164	2112235	123	38.68	98.41	1.0	1.0	3.5	.4	.8	125
1166	2135	54	38.69	98.44	6.0	4.3	11.9	5.2	5.7	160
1167	211235	99	38.68	98.40	.8	.8	2.9	2.9	1.1	125
1168	211235	35	38.67	98.40	2.8	2.1	6.5	2.9	1.9	160
1171	21125	5	38.66	98.37	1.8	1.5	5.3	5.5	1.9	125
1172	21125	291	38.67	98.36	.8	.9	2.5	5.5	1.2	75
1173	2125	324	38.70	98.34	.8	.9	3.1	2.9	1.3	150
1175	5150	20	38.70	98.32	5.8	5.3	11.9	124.2	5.3	310
1176	3112235	314	38.86	98.27	.8	1.3	3.4	1.9	1.1	40
1177	3112235	224	38.87	98.27	.5	1.0	2.5	1.9	1.1	40
1178	312235	212	38.87	98.29	1.5	1.5	2.2	.6	1.5	50
1180	3112235	170	38.88	98.30	1.5	2.0	5.0	3.0	2.2	75
1181	3112235	143	38.87	98.31	1.0	1.7	4.1	3.0	1.9	75
1183	311235	156	38.86	98.32	1.8	1.5	5.9	2.5	2.2	115
1184	311235	105	38.85	98.32	.5	.9	2.1	2.5	1.0	115
1186	3135	130	38.83	98.32	1.8	2.6	5.9	7.1	1.9	125
1187	311235	198	38.84	98.27	.8	1.4	4.0	2.3	1.8	75
1188	311235	225	48.84	98.25	1.8	2.1	4.5	2.3	2.2	75
1190	311235	202	38.82	98.27	1.3	1.8	4.1	7.0	2.0	115
1191	311235	234	38.81	98.26	1.0	1.6	3.4	7.0	1.6	115
1194	21125	109	38.67	98.36	.3	.6	1.5	8.3	.9	75
1195	21125	38	38.66	98.36	.8	1.1	3.2	8.3	1.6	100
1196	2125	33	38.65	98.33	5.5	3.2	7.9	6.4	2.9	125
1197	5125	7	38.64	98.31	6.8	5.6	12.2	4.7	5.8	200
1198	5125	12	38.71	98.28	1.0	2.0	3.6	1.2	1.9	200
1200	315	171	38.78	98.26	5.0	3.1	9.9	120.6	5.1	200

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1202	3112235	45	38.62	98.29	1.0	.9	5.1	3.2	2.2	75
1203	2112235	143	38.63	98.29	.3	.7	1.4	3.2	.8	75
1204	312235	20	38.61	98.28	1.8	.6	5.5	2.9	2.2	75
1206	2112235	48	38.65	98.28	2.3	2.1	4.4	.6	2.2	75
1207	2112235	153	38.66	98.27	.5	.5	1.1	.6	.8	75
1209	211235	26	38.67	98.28	1.5	1.3	3.5	1.3	1.9	75
1210	211235	85	38.68	98.29	.5	.7	2.1	1.3	.9	65
1213	31125	140	38.83	98.23	.8	.9	2.8	10.5	1.4	85
1214	31125	215	38.84	98.21	1.0	1.7	2.8	10.5	1.7	85
1215	3125	138	38.82	98.24	1.8	2.1	5.2	9.2	2.2	110
1216	3125	185	38.81	98.21	4.3	5.2	10.9	6.2	5.1	165
1217	3125	200	38.80	98.20	4.3	4.2	9.5	5.5	4.9	165
1218	3125	150	38.79	98.24	4.8	5.8	11.5	5.2	5.5	165
1220	31125	174	38.78	98.17	5.0	4.8	10.1	3.4	5.0	200
1221	31125	211	38.77	98.15	5.5	3.8	9.5	3.4	3.9	175
1222	3125	202	38.75	98.15	2.8	4.5	9.5	1.8	9.2	175
1224	51125	66	38.66	98.22	7.8	4.9	11.4	1.2	4.7	300
1225	51125	139	38.69	98.20	1.3	1.2	4.3	1.2	2.1	170
1227	5112235	66	38.61	98.26	2.0	2.1	7.0	1.2	3.1	100
1228	3112235	28	38.60	98.26	1.0	1.9	5.1	1.2	2.6	100
1230	3112235	101	38.58	98.26	1.0	1.1	4.3	3.3	1.9	75
1231	3112235	7	38.56	98.25	2.0	1.8	4.2	3.3	2.1	60
1232	312235	90	38.59	98.25	.5	.9	2.5	2.7	1.2	60
1233	312235	5	38.59	98.23	1.8	2.9	7.3	.8	3.2	75
1235	311235	44	38.59	98.22	4.3	3.1	8.5	1.1	3.9	150
1236	311235	9	38.58	98.20	4.0	3.4	7.8	1.1	3.5	165
1238	311235	8	38.59	98.19	1.0	1.3	4.0	1.2	1.8	110
1239	311235	270	38.60	98.18	.8	.7	3.2	1.2	1.3	75
1241	3135	148	38.63	98.18	.5	.7	3.1	3.1	1.4	100
1243	315	16	38.64	98.15	6.0	4.2	11.9	110.3	5.2	225
1244	315	159	38.73	98.14	3.5	1.2	10.9	108.3	3.9	225
1245	315	33	38.65	98.12	5.3	4.8	10.3	105.8	4.6	200
1246	3112235	57	38.57	98.19	1.3	1.6	3.9	1.8	2.1	115
1247	3112235	13	38.56	98.18	1.3	1.9	4.3	1.8	2.0	115
1248	312235	145	38.59	98.16	1.0	1.3	3.9	.7	1.4	75
1250	3112235	85	38.54	98.18	1.0	.9	3.1	3.0	1.3	100
1251	3112235	19	38.53	98.17	2.3	2.1	4.4	3.0	2.2	75
1252	312235	347	38.54	98.15	.8	1.9	3.9	1.9	2.1	60
1254	3135	156	38.58	98.14	.3	.8	1.1	10.6	1.1	50
1255	3135	3	38.56	98.13	.3	1.3	3.8	9.9	1.9	125
1256	3135	135	38.58	98.13	.5	.8	2.5	9.7	1.1	50
1257	3135	2	38.57	98.11	.8	1.2	4.0	9.1	1.8	110
1258	3135	59	38.60	98.12	2.5	1.6	7.0	7.0	2.3	160
1259	311235	38	38.55	98.12	1.3	1.7	4.1	4.9	1.8	110
1260	311235	357	38.55	98.10	2.0	1.8	5.4	4.9	2.5	75

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1263	31125	210	38.80	98.07	1.0	1.2	3.9	10.0	1.9	100
1264	31125	240	38.79	98.07	1.3	1.4	4.5	10.0	1.9	85
1265	3125	105	38.75	98.11	.8	.9	3.9	6.9	1.5	115
1267	315	12	38.63	98.07	2.0	2.0	5.9	98.0	2.8	160
1268	31125	170	38.80	98.05	1.8	4.3	9.9	6.7	4.5	200
1269	31125	190	38.80	98.04	2.5	2.7	7.9	6.7	3.4	200
1270	3125	196	38.75	98.02	2.0	2.8	6.5	3.5	3.1	150
1271	3125	204	38.71	98.01	4.0	2.9	8.1	.9	3.4	150
1273	315	50	38.64	98.03	2.0	2.8	6.5	92.2	3.1	175
1274	31125	65	38.54	98.07	3.8	1.6	6.0	5.4	2.8	100
1275	31125	343	38.53	98.05	.8	1.3	3.8	5.4	1.8	75
1276	3125	73	38.77	98.07	2.5	2.6	6.5	3.5	2.5	150
1277	3125	355	38.77	98.03	2.5	2.1	6.3	1.7	2.5	115
1278	3125	75	38.60	98.06	3.8	4.5	9.9	.5	4.7	165
1280	315	24	38.59	98.01	1.5	2.3	5.9	89.0	2.4	200
1281	315	174	38.66	97.97	9.5	6.6	14.3	87.2	6.7	200
1282	3112235	59	38.53	98.04	2.0	1.7	5.5	4.0	2.2	100
1283	3112235	23	38.53	98.03	1.3	1.3	4.3	4.0	1.9	100
1284	312235	98	38.56	98.02	1.5	2.2	5.5	2.2	2.4	110
1285	312235	58	38.53	98.00	3.5	3.3	8.4	.6	3.8	215
1287	3112235	71	38.50	98.01	1.0	1.3	3.9	3.3	1.9	75
1288	3112235	358	38.49	97.99	2.5	2.1	5.5	3.3	2.1	85
1290	3135	115	38.58	97.98	2.5	2.6	6.9	1.7	2.9	200
1292	31125	170	38.66	97.94	4.5	4.6	11.8	1.1	4.8	200
1293	31125	262	38.62	97.91	1.3	1.2	3.0	1.1	1.3	175
1295	315	171	38.62	97.88	2.8	3.2	8.4	75.2	3.2	165
1296	315	174	38.61	97.87	1.0	1.5	4.2	74.8	2.6	55
1297	315	199	38.61	97.85	3.3	2.5	7.5	74.6	2.5	200
1298	315	116	38.56	97.89	.8	1.2	2.4	71.4	1.2	75
1299	3112235	208	38.50	97.97	1.0	1.8	4.3	1.7	1.8	125
1300	3112235	343	38.50	97.96	2.5	2.9	8.5	1.7	3.1	125
1302	3112235	0	38.51	97.94	.5	1.2	4.1	1.0	1.8	110
1303	3112235	313	38.52	97.93	.8	1.3	4.5	1.0	1.9	110
1305	3135	345	38.54	97.94	1.0	1.8	5.5	4.6	2.2	175
1306	311235	6	38.52	97.91	.5	1.2	2.5	1.6	1.2	135
1307	311235	320	38.52	97.91	.5	1.0	2.8	1.6	1.3	135
1308	31235	22	38.52	97.92	1.0	2.0	5.8	1.0	2.5	160
1310	3135	2	38.52	97.89	2.3	3.1	7.1	1.5	3.3	210
1311	3135	21	38.54	97.88	.5	1.1	3.5	.5	1.4	100
1313	315	37	38.54	97.85	2.5	3.5	8.1	.8	3.8	210
1314	31125	71	38.52	97.85	2.5	3.5	8.1	.8	3.8	210
1315	31125	41	38.51	97.84	1.3	2.4	6.0	.8	2.8	160
1317	315	180	38.56	97.81	4.3	3.1	8.1	62.3	3.2	160
1318	31125	90	38.49	97.86	1.3	1.5	6.5	4.1	2.5	165

Table 12. (Continued)

Basin no.	ID	Az	Lat	Long	A	L	P	D		R
1319	31125	33	38.48	97.85	1.8	1.4	5.1	4.1	1.7	115
1320	3125	348	38.49	97.83	2.8	1.8	5.5	3.5	2.1	125
1321	3125	15	38.50	97.79	2.0	1.7	6.2	.5	2.9	110
1323	3112235	145	38.49	97.93	2.5	1.7	5.9	3.6	2.1	75
1324	3112235	71	38.47	97.94	2.0	2.0	5.5	3.6	2.2	110
1325	312235	82	38.46	97.92	1.0	1.9	5.5	2.3	2.2	120
1326	312235	48	38.45	97.91	2.5	2.7	7.2	1.9	2.6	125
1328	3112235	84	38.43	97.90	1.5	1.0	4.3	2.3	1.9	175
1329	3112235	358	38.41	97.89	1.8	1.6	4.2	2.3	2.1	175
1331	3135	148	38.48	97.88	5.3	5.6	12.1	7.8	5.7	165
1332	2135	48	38.43	97.86	2.8	2.4	7.5	7.0	3.0	175
1333	3135	3	38.43	97.84	.5	.8	2.2	6.4	1.1	85
1334	4135	4	38.43	97.83	.5	.9	2.5	5.7	1.3	75
1335	311235	113	38.43	97.84	1.3	1.9	4.1	4.5	1.6	150
1336	311235	44	38.39	97.86	2.0	1.9	5.5	4.5	2.2	150
1337	31235	25	38.39	97.84	2.0	1.5	6.0	3.2	2.3	75
1339	3135	312	38.48	97.75	3.3	1.3	8.1	3.2	3.6	125
1341	31125	185	38.59	97.78	1.0	1.3	4.1	3.9	1.4	150
1342	31125	248	38.59	97.78	1.0	1.3	4.1	3.9	1.4	150
1344	31125	35	38.49	97.74	1.0	1.7	4.5	2.3	1.9	75
1345	31125	359	38.48	97.73	1.8	1.7	5.3	2.3	2.2	85
1346	3125	357	38.47	97.71	9.5	5.0	14.9	.8	5.8	125
1348	31125	46	38.46	97.69	.8	.8	3.9	5.1	1.5	50
1349	31125	342	38.44	97.68	5.0	2.7	9.1	5.1	3.1	65
1250	3125	332	38.47	97.66	5.0	2.6	9.1	3.3	3.7	160
1351	3125	275	38.50	97.65	5.3	3.2	9.9	2.6	3.6	160
1353	31125	339	38.47	97.58	3.3	2.5	7.8	9.0	3.0	85
1354	31125	211	38.50	97.57	1.3	1.9	4.9	9.0	1.9	125
1355	3125	238	38.50	97.58	.8	1.2	3.5	8.0	1.4	100
1356	3125	248	38.51	97.59	1.3	1.5	4.9	6.9	1.3	150
1357	3125	240	38.52	97.60	.5	1.1	1.5	6.2	1.1	60
1358	3125	19	38.49	97.62	6.8	3.6	12.5	6.1	5.4	210
1359	3125	327	38.54	97.59	5.0	3.0	11.8	2.2	5.1	200
1360	3125	312	38.56	97.59	5.0	5.4	12.1	2.1	5.2	175
1362	31125	298	38.59	97.56	5.5	3.2	9.0	2.1	3.3	175
1363	31125	0	38.60	97.59	.3	1.1	1.9	2.1	1.2	75
1364	3125	13	38.60	97.60	.5	1.1	2.4	1.9	1.2	75
1366	31125	331	38.62	97.57	1.8	2.1	6.4	1.4	2.6	175
1367	31125	284	38.63	97.55	3.8	3.8	8.4	1.4	3.3	175
1369	31125	327	38.65	97.56	.5	1.2	5.2	.2	1.8	75
1370	31125	275	38.66	97.56	.3	.6	1.7	.2	1.2	55
1372	315	293	38.67	97.56	.5	.8	2.9	30.0	1.2	55
1373	31125	349	38.65	97.53	1.5	1.0	4.5	3.9	2.1	65
1374	31125	250	38.66	97.53	.3	.6	2.0	3.9	.9	55
1375	3125	255	38.67	97.53	1.0	1.1	3.8	3.2	1.3	60
1376	3125	352	38.66	97.55	1.3	1.5	4.9	2.8	2.2	75
1377	3125	237	38.70	97.56	.8	1.0	3.9	.7	1.8	110

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
1379	315	258		38.72	97.56	1.8	1.2	4.4	24.9	2.1	105
1380	315	262		38.75	97.55	2.8	3.1	6.9	21.6	2.9	110
1381	315	288		38.76	97.56	1.5	1.8	5.5	18.8	2.2	105
1382	31125	321		38.78	97.55	1.5	1.2	4.2	4.3	2.0	175
1383	31125	258		38.79	97.54	1.0	1.3	3.1	4.3	1.2	65
7	12233445	85	10.5	38.85	102.40	65.3	17.6	43.1	20.0	16.0	575
13	12233445	112	14.8	38.92	102.41	55.0	24.0	41.3	20.0	18.1	475
16	1233445	124	1.6	38.92	102.27	30.0	2.3	21.8	15.1	13.9	325
24	12233445	83	6.2	38.98	102.27	64.5	11.1	42.7	12.2	16.3	525
27	12233445	88	.2	38.95	102.21	6.4	.2	11.2	12.2	4.4	180
38	42445	118	11.5	38.97	102.00	42.0	15.4	33.4	8.0	14.7	850
44	12233445	96	1.6	39.06	102.06	26.0	2.0	27.2	19.3	11.2	300
47	12233445	52	3.2	39.03	102.02	9.5	4.1	15.1	19.3	6.1	175
50	1233445	154	1.5	39.09	101.99	3.8	1.6	8.9	18.0	3.8	225
66	42233445	102	3.5	39.00	101.91	11.0	4.2	18.0	3.0	7.9	375
67	42233445	135	1.3	39.01	101.88	4.3	1.5	8.6	3.0	3.8	325
71	22445	182	1.8	38.99	101.79	5.0	2.0	11.2	1.9	4.9	225
78	4250	76	6.8	38.87	101.82	58.0	10.0	42.8	393.5	16.5	525
81	4250	28	4.4	38.83	101.67	34.0	7.4	27.8	389.0	10.2	475
85	22235	129	2.0	39.00	101.73	5.0	2.0	11.4	10.5	4.8	275
88	22235	165	1.7	39.00	101.70	3.0	1.7	8.7	10.5	3.7	275
95	2235	172	5.2	38.98	101.65	12.5	6.2	18.1	3.0	8.0	325
102	225	133	4.9	38.95	101.58	15.0	5.4	21.3	381.1	4.9	450
110	4223345	102	7.8	39.08	101.85	30.0	10.7	32.5	8.7	14.2	375
116	1223345	129	6.9	39.12	101.84	26.5	9.0	27.7	8.7	11.9	375
125	123345	147	5.3	39.13	101.78	25.8	8.7	29.0	7.2	11.5	350
132	223345	0	.2	39.05	101.67	3.3	.2	7.2	3.6	3.0	160
137	4223345	129	.4	39.11	101.67	3.0	.2	8.7	3.5	3.8	225
140	4223345	159	1.6	39.12	101.66	3.8	1.8	9.9	3.5	4.1	250
144	4245	157	2.4	39.10	101.62	6.0	3.0	14.0	25.8	6.3	325
147	4245	164	1.6	39.09	101.60	4.8	1.8	10.0	25.0	4.1	300
153	2245	90	2.8	39.03	101.62	10.5	4.2	19.3	21.2	6.0	350
157	2245	40	.7	39.01	101.57	2.5	.6	7.6	20.0	2.9	225
161	2245	160	1.6	39.05	101.54	4.3	1.6	10.9	17.4	5.0	300
165	2245	185	2.3	39.04	101.50	4.8	2.8	9.9	15.3	4.0	225
173	1223345	89	6.7	39.02	102.70	30.8	9.8	27.8	114.7	11.5	275
177	1223345	113	4.7	39.04	102.70	10.3	5.5	15.7	114.7	7.2	200
181	123345	120	3.0	39.06	102.63	12.5	4.8	16.8	112.4	6.9	225
184	123345	23	.8	39.00	102.57	15.0	.7	17.6	110.0	7.5	150
187	123345	113	.8	39.07	102.60	18.0	.8	17.3	108.8	7.0	225
191	123345	156	.1	39.09	102.53	4.6	.2	8.8	105.7	3.6	160
199	123345	52	5.8	39.01	102.50	21.8	7.5	21.1	99.0	9.0	275
202	123345	48	3.2	39.01	102.44	22.5	4.3	21.4	94.5	9.8	325
212	123345	102	1.4	39.17	102.03	12.8	2.0	18.8	56.1	7.9	150

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
215	123345	68	6.2	39.10	102.09	53.8	10.2	43.2	53.5	18.9	350
222	123345	92	22.3	39.19	102.15	61.3	38.3	67.0	46.4	30.0	600
240	423345	160	.9	39.19	101.63	5.2	1.0	10.0	22.9	4.0	110
251	423345	165	1.7	39.16	101.44	7.5	2.9	13.6	13.0	5.3	150
260	423345	80	1.3	39.10	101.48	11.3	2.1	15.1	5.0	5.7	150
271	4223345	136	10.6	39.19	101.59	33.9	13.1	35.1	7.7	15.1	175
274	2223345	123	1.4	39.13	101.43	3.8	1.8	9.7	7.7	4.2	100
282	2245	112	2.0	39.03	101.40	9.5	2.2	14.1	12.6	6.4	175
285	4245	206	1.2	39.05	101.35	5.3	1.5	11.2	10.9	5.0	150
291	4245	196	2.2	39.04	101.35	7.0	3.0	12.7	7.0	4.9	175
297	225	24	2.0	38.88	101.28	9.3	2.4	13.7	359.0	5.1	400
303	425	175	7.9	39.00	101.25	14.5	9.2	23.7	357.7	10.3	600
307	425	169	.8	38.97	101.19	29.1	.4	23.2	353.3	10.3	375
317	425	162	10.3	39.00	101.11	35.0	15.0	37.4	347.0	10.9	425
321	425	186	2.6	38.93	101.01	30.8	3.5	23.8	343.1	9.3	425
326	225	173	3.3	38.87	100.92	9.3	4.4	17.2	333.0	7.4	375
331	1223345	99	26.5	38.73	102.26	90.0	27.2	73.9	112.4	33.0	775
334	1223345	113	1.4	38.72	102.07	28.3	1.5	25.9	112.4	11.7	300
337	123345	114	8.1	38.75	101.86	51.3	10.0	39.0	96.0	17.2	375
344	123345	110	47.2	38.82	102.09	308.8	66.7	124.0	85.7	53.8	1150
348	123345	105	2.6	38.62	101.67	92.5	2.7	49.5	73.0	22.3	400
362	423345	80	21.4	38.72	101.33	200.0	34.8	96.0	96.8	43.6	875
376	4223345	92	5.0	38.79	101.45	73.3	8.8	40.5	35.8	17.6	475
379	4223345	56	.3	38.76	101.36	14.0	.6	21.5	35.8	9.1	375
383	423345	138	2.8	38.83	101.28	10.0	2.8	17.5	28.6	8.1	300
396	225	182	2.2	38.86	100.84	16.3	3.1	19.0	328.2	7.6	425
405	425	38	5.3	38.68	100.78	45.8	8.2	30.7	318.2	11.1	475
413	425	40	11.6	38.63	100.68	152.0	14.3	57.8	306.8	24.0	525
417	425	10	2.3	38.65	100.53	39.0	4.8	29.3	303.9	11.8	425
423	42235	127	11.8	38.87	100.69	122.0	18.3	67.3	5.4	30.0	800
426	42235	165	3.8	38.84	100.52	21.0	5.4	24.4	5.4	10.5	425
434	425	356	4.0	38.69	100.26	27.5	6.4	23.9	287.6	8.8	275
438	42235	137	5.2	38.87	100.41	48.0	7.2	36.3	7.4	14.8	385
441	22235	96	1.6	38.80	100.39	18.3	2.4	19.7	7.4	7.7	190
450	425	8	.4	38.72	100.17	19.0	.4	18.9	277.3	7.3	310
467	1223345	99	12.8	39.09	101.20	77.8	19.2	79.8	43.5	19.2	325
471	1223345	139	3.0	39.11	101.10	21.3	3.9	28.3	43.5	12.3	250
477	123345	152	.7	39.06	100.94	3.5	.8	9.7	35.6	4.3	150
482	123345	149	1.3	39.03	100.88	1.3	1.2	9.0	28.0	3.9	100
487	123345	138	5.7	39.05	100.84	11.3	6.0	19.8	20.6	8.9	225
500	1223345	104	8.3	39.10	100.92	63.5	11.3	35.7	24.3	15.9	325
504	1223345	132	2.0	39.10	100.82	9.0	2.4	12.7	24.3	5.3	125
514	123345	170	1.5	39.06	100.66	3.3	1.7	8.9	10.4	3.9	150
523	1245	163	2.6	38.99	100.56	4.0	2.9	14.2	58.5	6.1	150
532	1245	94	25.4	38.96	100.80	77.5	38.2	66.0	57.8	30.4	575
536	1245	176	1.8	39.00	100.51	7.3	2.0	12.3	54.0	5.2	225

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
542	122345	120	4.7	39.03	100.47	22.3	6.6	30.9	8.8	14.3	200
545	122345	137	.7	39.01	100.41	3.8	1.0	10.2	8.8	3.1	85
550	12345	175	1.2	39.01	100.38	3.8	1.8	9.2	7.0	3.7	150
561	4245	163	2.9	38.91	100.07	30.5	3.6	23.8	3.2	9.8	250
566	42235	150	4.5	38.89	100.00	30.8	6.4	28.1	5.9	10.0	325
569	422335	185	.8	38.89	99.95	10.3	.8	16.9	5.9	7.6	275
572	2235	183	.1	38.89	99.93	5.2	.2	15.2	1.[illegible]	6.6	255
579	42235	60	4.1	38.70	100.01	34.8	7.0	24.9	6.3	8.7	275
586	42235	2	4.1	38.68	99.95	17.3	7.0	19.1	6.3	7.1	225
591	425	165	6.6	38.86	99.92	12.0	8.9	22.7	260.7	10.3	325
595	225	6	2.9	38.75	99.89	6.3	3.1	12.1	259.7	5.0	275
601	225	147	4.2	38.84	99.88	11.5	6.0	18.0	256.0	8.8	275
606	42235	138	6.1	38.88	99.87	13.3	7.5	19.7	3.7	8.7	225
609	42235	163	1.2	38.86	99.84	5.0	1.6	12.2	3.7	5.1	225
615	4235	189	2.2	38.85	99.81	5.0	3.0	10.4	1.6	4.4	225
624	42235	37	4.9	38.68	99.85	33.8	8.3	24.3	4.6	10.2	325
627	42235	353	1.7	38.69	99.78	8.0	2.0	12.6	4.6	4.4	225
630	4235	334	1.8	38.70	99.75	7.3	2.0	10.7	3.0	3.9	225
635	425	147	2.0	38.84	99.77	10.5	2.3	12.8	244.0	5.2	275
638	425	0	2.7	38.74	99.71	12.8	3.4	15.8	241.3	6.7	325
641	425	157	3.0	38.84	99.72	9.3	3.4	16.6	240.3	6.7	325
644	425	169	3.8	38.84	99.68	12.8	4.6	17.4	238.3	7.4	300
650	225	174	1.6	38.84	99.65	11.2	1.8	16.1	235.8	7.1	325
655	42235	60	2.7	38.73	99.66	11.0	3.9	13.5	2.1	6.2	350
658	42235	3	1.5	38.73	99.62	5.5	1.7	9.5	2.1	3.5	200
665	22235	33	1.3	38.73	99.59	4.3	1.4	9.1	1.9	3.1	300
668	22235	345	1.5	38.73	99.57	3.0	1.7	7.9	1.9	3.0	225
677	225	160	7.0	38.84	99.58	24.8	10.0	25.1	228.0	10.5	350
682	225	187	3.8	38.83	99.51	19.5	4.6	20.8	227.3	7.8	325
687	225	35	1.9	38.72	99.50	5.5	2.0	10.7	225.5	4.8	275
692	22235	159	1.6	38.79	99.48	7.0	2.1	11.1	1.1	4.2	225
695	22235	190	.7	38.79	99.46	3.8	1.1	10.5	1.1	4.4	225
701	225	180	.4	38.76	99.40	9.5	.4	13.9	219.7	6.0	170
708	225	58	5.7	38.69	99.49	18.5	7.8	22.1	220.2	8.6	325
712	225	45	2.2	38.68	99.40	9.3	3.2	12.2	218.0	4.8	150
717	22235	152	4.2	38.81	99.38	7.8	5.0	18.6	4.8	7.9	250
720	22235	180	.7	38.79	99.35	5.0	.7	11.3	4.8	4.2	125
724	2235	142	7.0	38.80	99.41	20.8	7.2	27.0	3.0	11.5	275
728	2235	115	.8	38.73	99.37	2.3	.8	6.4	.9	3.0	125
732	4223345	114	1.9	38.65	99.71	7.5	2.1	11.4	16.2	4.7	150
735	4223345	152	1.0	38.67	99.70	8.8	1.2	13.5	16.2	5.5	150
738	423345	137	.3	38.64	99.64	8.0	.3	15.9	10.1	7.3	275
745	223345	91	2.0	38.58	99.61	14.3	2.3	5.4	7.0	9.0	275
751	4223345	152	2.2	38.69	99.60	12.3	3.0	20.6	8.8	7.5	275
754	2223345	137	1.5	38.66	99.59	3.5	1.7	8.8	8.8	3.9	200
761	2245	149	2.1	38.65	99.49	8.8	2.8	13.1	21.0	5.7	140
768	2245	9	2.8	38.59	99.43	6.6	2.9	10.6	17.2	4.2	250

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		$\bar{R}$
776	2245	2	1.0	38.60	99.36	5.0	1.0	10.8	10.9	3.7	155
786	225	12	4.6	38.64	99.26	12.3	6.2	16.6	207.8	7.3	250
795	525	29	4.5	38.65	99.13	23.0	6.0	23.5	188.8	9.4	210
798	525	205	.4	38.74	99.09	5.8	.7	9.5	188.0	3.4	100
802	225	7	8.1	38.64	99.08	30.0	9.5	26.2	186.8	11.1	200
805	225	351	6.8	38.67	99.04	18.8	8.0	18.0	185.0	9.1	200
808	525	350	1.8	38.70	99.01	10.3	2.5	13.5	180.6	5.9	110
811	525	140	1.2	38.76	99.01	4.5	1.3	9.2	179.4	3.4	190
814	525	162	1.1	38.77	98.98	3.8	1.2	7.5	178.6	3.1	200
818	325	2	.2	38.76	98.90	2.5	.2	4.5	172.5	2.2	190
825	122345	105	15.6	39.09	100.59	52.3	21.2	46.7	79.6	22.2	200
830	1223345	124	5.3	39.09	100.47	26.3	6.7	31.0	79.6	19.5	225
843	123345	139	6.9	39.08	100.29	15.3	10.6	23.0	64.8	10.2	200
848	123345	163	1.7	39.03	100.17	7.3	2.0	14.5	57.1	2.1	175
852	123345	153	2.3	39.01	100.09	8.0	2.8	11.2	50.5	4.6	150
856	123345	146	2.1	39.01	100.04	8.8	2.2	13.9	42.7	5.8	150
861	123345	142	1.7	39.01	99.96	7.0	1.9	13.9	32.9	6.2	110
872	123345	45	2.4	38.93	99.85	8.3	4.1	11.5	23.3	4.1	150
883	423345	134	4.5	38.95	99.76	7.5	5.7	16.5	9.9	5.0	200
888	423345	143	2.6	38.96	99.72	11.0	3.7	13.6	7.2	6.2	225
901	4223345	128	8.9	39.01	99.72	39.5	15.3	40.2	2.6	15.7	300
904	4223345	167	1.6	38.99	99.64	9.0	1.9	11.3	2.6	5.1	210
909	4245	153	4.1	38.98	99.60	8.3	6.1	13.5	61.7	6.6	175
912	4245	168	2.5	38.98	99.57	9.0	3.1	12.1	60.5	5.7	175
917	2245	170	4.0	38.97	99.54	7.8	4.6	11.4	56.9	5.2	200
925	222345	160	2.8	38.97	99.45	4.8	2.7	9.9	2.9	5.2	160
928	22345	183	1.2	38.97	99.42	6.5	1.6	11.3	2.9	5.2	175
934	2245	15	1.8	38.88	99.42	6.0	2.0	11.0	47.2	3.1	260
938	2245	185	4.1	38.97	99.39	9.3	4.2	15.5	46.3	6.8	210
943	2245	201	1.6	38.93	99.35	5.0	2.1	10.8	43.0	4.2	170
948	2245	182	4.2	38.90	99.32	6.3	4.5	14.8	37.9	7.1	225
952	2245	172	4.7	38.88	99.29	8.8	5.7	15.5	34.0	7.6	210
955	2245	98	2.0	38.82	99.33	10.3	2.0	14.5	32.8	6.0	210
958	2245	184	3.9	38.87	99.26	13.0	6.1	17.0	31.6	7.7	215
965	2245	80	3.4	38.77	99.27	11.8	5.7	18.2	27.0	7.2	185
971	2245	142	.9	38.81	99.19	10.3	1.4	12.9	21.3	6.1	120
975	222345	116	1.7	38.98	99.34	18.5	2.1	17.9	18.2	7.2	200
978	222345	163	2.0	38.99	99.28	6.8	2.2	11.4	18.2	5.2	160
983	22345	160	2.1	38.98	99.25	10.5	3.6	14.9	14.7	6.8	150
988	22345	167	4.4	38.94	99.20	16.0	5.8	23.5	7.4	10.7	225
991	22345	163	3.7	38.90	99.14	25.0	4.7	26.4	2.1	12.6	275
998	2245	155	2.5	38.84	99.08	7.3	3.0	12.1	12.9	5.5	110
1002	222345	149	2.6	38.98	99.16	5.0	3.1	13.3	19.3	6.1	175
1006	222345	173	2.5	38.98	99.14	4.3	3.0	10.1	19.3	6.1	165
1011	22345	165	1.2	38.95	99.11	6.5	1.6	10.2	15.6	4.6	150

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
1019	2245	160	1.2	38.86	98.97	6.5	1.5	13.2	5.0	5.2	160
1022	5245	191	.8	38.84	98.93	7.0	1.1	11.1	2.1	4.1	160
1028	525	182	.5	38.81	98.86	1.5	.8	6.3	168.0	2.9	210
1038	525	35	7.8	38.71	98.89	57.3	11.4	32.3	1.0	12.1	325
1043	22235	148	4.6	38.86	98.85	31.0	7.2	17.9	1.9	11.1	210
1046	22235	197	2.2	38.84	98.79	4.8	5.0	11.9	1.9	5.2	175
1051	22235	30	1.1	38.63	98.86	3.5	1.1	8.1	15.1	3.1	100
1054	22235	329	1.3	38.62	98.83	7.5	1.5	10.3	15.1	3.7	100
1057	2235	331	2.0	38.64	98.81	7.0	1.2	5.9	10.6	2.2	125
1062	2235	340	1.9	38.68	98.78	5.3	2.1	9.9	7.5	4.4	110
1067	525	159	.2	38.83	98.75	7.3	.2	11.2	159.5	4.7	175
1073	525	19	7.0	38.72	98.72	33.5	9.5	27.5	156.4	11.7	325
1077	525	156	3.3	38.84	98.70	9.5	4.4	13.0	155.3	5.8	225
1089	22235	21	6.0	38.69	98.66	26.5	8.2	15.5	5.7	8.5	200
1093	22235	73	1.2	38.74	98.66	5.0	1.8	11.5	5.7	4.0	150
1100	525	169	3.5	38.85	98.60	12.8	4.8	16.1	149.2	6.6	210
1104	525	164	1.9	38.84	98.56	7.0	3.5	12.1	145.6	5.3	165
1107	525	28	.5	38.78	98.54	2.3	.6	5.1	143.2	2.3	200
1110	525	183	2.9	38.84	98.51	4.3	3.2	9.4	141.7	4.0	200
1117	22235	2	3.2	38.66	98.54	9.5	4.8	12.8	10.5	4.5	175
1120	22235	55	1.2	38.67	98.58	10.3	1.8	14.3	10.5	5.4	175
1124	2235	83	1.9	38.71	98.59	10.0	2.4	15.5	8.8	6.1	175
1127	2235	130	1.1	38.75	98.55	6.8	1.2	10.1	6.0	3.5	160
1132	525	167	3.8	38.82	98.46	5.5	5.2	11.0	135.0	5.2	205
1135	525	189	.8	38.83	98.43	5.0	1.0	8.4	134.3	4.0	225
1138	525	38	4.2	38.75	98.45	5.5	5.6	11.5	132.8	5.1	260
1143	525	42	8.9	38.72	98.48	23.5	10.4	27.9	131.9	11.9	350
1148	32235	199	3.8	38.86	98.35	8.3	4.7	13.8	4.9	5.9	150
1155	32235	159	3.2	38.85	98.38	11.3	3.5	14.9	4.9	6.9	160
1158	3235	202	.8	38.67	98.44	2.3	1.0	6.5	8.8	2.6	150
1162	22235	43	.8	38.67	98.44	2.3	1.0	6.5	8.8	2.6	150
1165	22235	163	.4	38.67	98.41	3.0	.4	5.0	8.8	2.3	150
1169	2235	11	2.5	38.69	98.39	6.0	2.9	11.8	3.8	4.6	260
1174	525	40	5.8	38.70	98.35	10.5	3.2	16.9	124.9	7.6	360
1179	32235	240	.3	38.87	98.28	3.5	1.9	4.1	9.0	2.7	75
1182	32235	162	.4	38.88	98.31	3.0	.6	6.5	9.0	2.7	90
1185	3235	156	.3	38.86	98.32	2.5	.3	6.5	8.2	2.8	120
1189	3235	222	2.2	38.83	98.27	4.5	2.3	10.5	6.2	3.9	160
1192	3235	210	2.8	38.80	98.27	4.8	3.0	11.5	2.3	5.0	200
1199	525	34	5.5	38.68	98.30	21.3	8.3	24.1	121.6	9.5	300
1205	52235	29	2.6	38.63	98.28	5.3	3.2	11.5	5.5	4.8	135
1208	22235	63	.3	38.65	98.28	3.3	.6	5.3	5.5	2.8	140
1211	2235	74	1.1	38.67	98.27	3.0	1.3	6.1	4.2	2.9	125
1219	325	169	8.9	38.77	98.21	23.3	10.5	24.1	117.0	10.1	250
1223	325	183	3.3	38.77	98.17	20.0	3.4	115.3	8.3	260	

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
1226	525	92	.9	38.67	98.21	10.3	1.2	13.5	113.0	5.3	325
1229	52235	70	1.0	38.61	98.26	4.0	1.2	8.5	7.3	3.6	125
1234	32235	22	2.6	38.59	98.25	7.0	3.3	12.4	7.3	4.9	125
1237	3235	21	.9	38.58	98.21	8.8	1.1	3.5	5.0	4.7	175
1240	3235	152	1.2	38.60	98.18	2.8	1.2	3.5	5.0	1.6	150
1249	32235	96	1.3	38.57	98.17	5.8	1.8	11.0	11.4	4.1	175
1253	32235	24	2.2	38.55	98.17	5.3	3.0	9.5	11.4	4.3	175
1261	3235	5	4.8	38.59	98.10	7.5	4.9	16.8	2.1	7.2	250
1266	325	178	7.3	38.74	98.08	22.3	10.0	21.3	103.8	9.2	300
1272	325	174	6.9	38.76	98.04	20.8	.0	24.8	95.0	11.2	400
1279	325	47	5.6	38.58	98.05	23.0	5.4	19.9	90.0	7.5	200
1286	32235	85	2.9	38.55	98.01	12.5	4.0	14.5	4.8	5.1	225
1289	32235	24	3.0	38.51	97.98	7.0	3.3	12.0	4.8	5.1	175
1294	325	1	.8	38.65	97.93	7.3	1.1	13.9	85.2	5.9	225
1301	32235	12	1.3	38.51	97.97	4.3	1.7	9.8	5.7	4.2	175
1304	32235	328	1.0	38.52	97.94	2.0	1.0	6.5	5.7	2.6	175
1309	3235	29	1.3	38.53	97.92	3.0	1.6	9.1	2.4	3.5	200
1316	325	64	.6	38.52	97.84	4.5	..8	10.4	64.2	4.1	220
1322	325	52	3.9	38.59	97.88	11.5	4.1	15.7	59.6	6.2	225
1327	32235	106	2.0	38.47	97.91	13.8	3.6	14.8	8.6	5.2	200
1330	32235	36	2.4	38.43	97.89	5.8	2.3	10.5	8.6	4.2	210
1338	3235	26	4.0	38.41	97.83	12.5	4.5	15.9	7.7	5.9	250
1343	325	169	3.8	38.57	97.78	5.8	3.9	12.4	59.0	5.3	275
1347	325	10	2.3	38.48	97.72	13.8	2.3	16.1	52.6	6.3	150
1352	325	333	4.3	38.48	97.67	20.0	5.1	19.9	50.7	6.9	215
1361	325	350	9.2	38.53	97.60	39.3	9.0	31.1	39.9	12.3	300
1365	325	335	2.0	38.60	97.57	7.5	2.1	12.1	36.3	1.9	210
1368	325	331	1.7	38.62	97.56	7.0	1.4	10.1	32.5	1.8	185
1371	325	307	.2	38.66	97.56	1.0	.2	3.8	31.2	1.8	80
1378	325	321	3.6	38.68	97.54	10.8	3.9	14.5	25.6	6.0	115
1384	325	14	4.6	38.81	97.55	11.8	4.3	13.5	3.2	6.1	250
17	133445	84	11.1	38.90	102.30	174.5	20.0	74.3	19.0	29.3	800
31	133445	117	6.2	38.98	102.24	100.3	12.2	58.8	19.0	22.6	650
63	433445	135	10.9	. 4	101.93	79.8	19.3	52.1	7.0	20.9	600
68	433445	107	2.5	39.00	101.90	18.3	3.0	24.2	7.0	10.2	425
96	235	145	7.0	38.97	101.68	44.3	10.5	29.3	387.3	11.7	500
134	43345	105	7.2	39.10	101.78	118.0	8.7	49.7	27.4	20.2	600
141	43345	152	2.8	39.10	101.65	10.3	3.5	16.1	27.4	7.1	350
262	43345	97	66.4	39.13	102.12	600.3	145.2	176.6	14.4	76.3	1500
279	43345	164	4.6	39.05	101.39	50.2	7.7	46.1	14.4	18.0	250
363	43345	79	56.5	38.69	101.70	1274.0	112.4	220.0	8.0	88.2	1850
390	43345	95	21.1	38.80	101.29	221.0	35.8	83.5	8.0	38.8	875
428	435	124	3.8	38.88	100.68	167.8	5.4	76.3	299.0	33.7	875
443	435	129	3.8	38.85	100.37	94.8	7.4	46.7	284.7	13.6	450
494	13345	105	26.0	39.05	100.96	207.9	43.5	96.3	50.0	45.1	725

Table 12. (Continued)

Basin no.	ID	Az	B	Lat	Long	A	L	P	D		R
520	13345	128	14.3	39.06	100.72	101.0	24.3	66.7	60.0	29.8	575
553	1345	144	4.1	39.01	100.43	49.5	8.8	40.9	37.7	17.2	425
573	435	152	3.9	38.88	99.98	54.5	5.9	33.8	261.9	13.8	375
588	435	28	4.0	38.70	99.97	61.3	6.3	71.8	261.4	12.5	425
616	435	161	2.3	38.87	99.84	30.5	2.4	25.6	253.2	11.0	350
632	435	35	3.2	38.70	99.82	56.3	4.4	34.9	247.2	13.3	325
659	435	37	1.5	38.74	99.64	16.3	2.1	18.0	233.2	7.1	450
670	235	21	1.2	38.74	99.58	10.3	1.9	14.9	231.0	4.6	350
696	235	167	.9	38.79	99.47	11.3	11.1	13.3	223.3	5.3	250
729	235	148	3.4	38.80	99.39	40.5	7.2	33.0	214.5	13.1	350
748	23345	100	10.4	38.62	99.64	66.8	16.2	44.1	22.2	16.9	325
757	23345	137	5.3	38.64	99.55	37.5	8.8	31.7	22.2	13.0	475
893	43345	97	43.6	39.02	100.20	345.3	79.6	144.3	66.0	67.1	925
905	43345	128	1.6	39.01	99.72	49.8	2.6	40.8	66.0	16.7	325
929	2345	167	2.0	38.97	99.43	14.3	2.9	16.5	48.0	7.2	210
992	2345	144	14.8	38.93	99.21	118.0	2.3	54.5	16.2	21.9	400
1015	2345	142	12.3	38.91	99.09	44.0	19.3	39.6	7.9	18.1	650
1048	535	156	.7	38.86	98.84	39.0	1.9	31.8	163.4	11.9	260
1064	535	18	10.9	38.70	98.81	50.5	15.1	32.5	161.4	14.1	315
1096	535	35	4.4	38.72	98.65	43.3	5.7	34.2	149.4	12.6	315
1128	535	41	7.7	38.71	98.56	50.0	10.5	34.5	137.4	12.9	275
1159	335	174	4.0	38.84	98.37	28.3	3.7	26.0	127.8	9.4	225
1170	535	56	6.3	38.71	98.41	27.8	8.8	25.9	126.2	9.7	350
1193	335	182	8.0	38.83	98.29	30.0	9.0	25.9	123.8	10.8	270
1212	535	41	4.3	38.65	98.26	18.3	5.5	22.9	117.4	9.4	360
1242	535	30	4.5	38.61	98.21	29.5	7.3	23.5	112.6	9.2	275
1262	335	37	6.7	38.59	98.12	32.5	11.4	30.5	98.4	8.8	350
1291	335	38	4.2	38.55	97.98	27.8	4.8	25.6	84.6	9.2	250
1312	335	72	4.8	38.53	97.93	21.5	5.7	21.1	70.0	9.0	300
1340	335	35	6.8	38.44	97.84	65.0	8.6	40.9	59.2	12.2	375
40	4445	94	16.9	38.95	102.17	390.1	19.0	111.1	398.5	44.6	1700
73	4445	122	3.6	39.02	101.91	123.3	7.0	58.9	398.5	23.7	700
168	445	124	15.1	39.08	101.68	209.5	27.4	80.2	372.5	34.1	925
294	445	112	10.6	39.15	101.99	712.1	14.4	200.7	361.1	82.8	1725
393	445	80	4.0	38.69	101.50	1510.5	8.0	17.9	328.4	92.0	1250
562	445	109	30.1	38.98	100.61	650.4	60.0	167.1	269.1	74.8	1150
778	445	64	13.4	38.62	99.51	185.3	22.2	71.7	210.1	26.3	515
1023	445	102	38.7	38.96	99.68	861.1	80.6	376.0	170.9	104.0	1250
1385	55	90	230.7	38.84	100.11	8534.0	398.5	590.4	0	285.2	3550